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ABSTRACT

This report focuses on research and development activities related to the 1983-85 Instructional Microcomputer Project for Arkansas Classrooms (IMPAC), under the supervision of the Arkansas Commission on Microcomputer Instruction. The report includes five major sections: (1) research findings that relate to achievement levels in mathematics, reading, and language arts in the elementary school affected by methods other than those involving computer technology; (2) research findings that relate to achievement levels in mathematics, reading, and language arts in the elementary school affected by methods directly related to computer technology, especially computer assisted instruction (CAI); (3) evaluation of IMPAC experimental programs including achievement scores and hardware, software, maintenance, and in-service training; (4) suggestions for implementing cost- and educationally-effective basic skills guidelines involving Computer Managed and Computer Assisted Instruction (CMI-CAI); (5) recommendations for program implementation in grades 3-8 in Arkansas School Districts over the next four years. The report concludes with recommendations for selecting and purchasing hardware and software, recommendations for in-service training, and a discussion of electrical and space requirements for microcomputers. A bibliography containing 73 references is appended. (Author/DR)

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A Research Report

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IMPAC

Instructional Microcomputer
Project for
Arkansas Classrooms

Arkansas Department
of Education

AFFECTING BASIC SKILLS ACHIEVEMENT THROUGH TECHNOLOGY

A RESEARCH REPORT ON IMPAC

IMPAC

Instructional Microcomputer

Project for

Arkansas Classrooms

Prepared by the
Arkansas Commission on Microcomputer Instruction
Department of Education
Little Rock, Arkansas 72201

AFFECTING BASIC SKILLS ACHIEVEMENT THROUGH TECHNOLOGY

A RESEARCH REPORT PREPARED
BY
DR. CECIL W. McDERMOTT
IMPAC PROJECT DIRECTOR

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STATE DEPARTMENT OF EDUCATION

December 15, 1985

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INTRODUCTION

This is a report on the research and development activities that relate to the 1983-85 Instructional Microcomputer Project for Arkansas Classrooms (IMPAC) under the supervision of the Arkansas Commission on Microcomputer Instruction. The report includes five major sections:

1. Review of research findings which relate to achievement levels in mathematics, reading and language arts in the elementary school affected by methods other than those involving computer technology

2. Review of research findings which relate to achievement levels in mathematics, reading and language arts in the elementary school affected by methods directly related to computer technology especially computer assisted instruction

3. Evaluation of the IMPAC experimental programs including achievement scores and the hardware, software, maintenance and in-service training

4. Action research related to the development of guidelines for implementing cost effective and educationally effective basic skills programs involving CAI or CMI-CAI

5. Conclusions and recommendations that should provide a guide to program implementation in grades 3 - 8 in Arkansas School Districts over the next four years.

Outcomes From a Systems Approach to Research

The application of statistical and mathematical techniques to develop models or simulation programs to aid in the administrative decision making process is referred to as systems analysis. Although quantitative analytical techniques do not furnish all the necessary information for decision making, they are of substantial help. Research in IMPAC is designed to provide a tool for decision making in an attempt to maximize the return on educational dollars using technology to enhance learning in high priority areas.

Data bases designed to interact with statistical and applied mathematics forecasting programs can provide continuous monitoring of programs so that the effect of improvements on educational programs can be considered and current and alternative program cost compared. The most feasible and acceptable means for accomplishing a given purpose usually results from analysis of data tempered with a knowledge of the human resources available, the educational priorities and public being served.

The application of systems analysis to IMPAC projects will continue to require communications between experimental sites, the monitoring of projects on a year to year basis and a staff that can help teachers respond to changes in the variables that affect learning. Since controls may need to be imposed, a good working relationship between administrators and teachers must be established. Such cooperation will be enhanced if IMPAC can provide guidelines for action and promised results are clearly visible and justify the means.

Technologists are creating efficient and effective learning tools through the use of minicomputers, microcomputers and interactive video. The key to instructional integration of these tools is to successfully combine them into interpersonal, peer group interaction and cognitive problem solving activities that help develop student curiosity and self confidence thus enhancing retention and encouraging an interest in more learning. The success of computer enhanced collaborative interactive learning will be a function of time on task, peer group teacher-principal reinforcement, realistic student goals and the efficient targeting of objectives followed by direct CAI instruction.

The desired outcomes are clear. IMPAC through its in-service activities and program implementation procedures wants to encourage the following outcomes:

1. Teacher directed activities in the context of a balanced basic skills, enrichment and special needs curriculum
2. Classroom management that targets basic skills and provides computer assisted instruction for 12 - 20 minute periods 5 days in 10 in not more than two basic skill areas
3. Scheduled opportunities for students and parents to see the results of a monitored basic skills achievement program
4. Opportunities for verbal interaction by students in problem solving situations
5. Instructional experiences that help students develop self confidence and achieve realistic educational goals.

The IMPAC staff is motivated to work with teachers and principals in developing a positive reinforcing classroom atmosphere. This human endeavor is enhanced by the Program for Effective Teaching (PET) and the Classroom Management Program currently in use in most Arkansas classrooms. Technology from the IMPAC perspective provides instructional tools to be used under the direct control of the classroom teacher.

IMPAC PROGRAMS AND RELATED ACTIVITIES

Act 528 of the 1983 session of the Arkansas Legislature relates to the establishment of pilot programs to find cost effective ways to utilize microcomputers in improving the teaching of basic skills in mathematics, reading and language arts in the elementary school grades. The Arkansas Commission on Microcomputer Instruction is carrying out that responsibility through IMPAC.

IMPAC has been involved in the development, implementation and evaluation of four programs in twenty-two Arkansas school districts involving 108 classroom teachers and 2,808 students, grades 4-6. A brief description of each program is given below:

Computer-Managed and Computer-Assisted Instruction (CMI-CAI)

A CMI-CAI program was conducted to find ways to use microcomputers for basic skills instruction in mathematics, reading and language arts. Courseware and management software were on a Corvus hard disk networked to twenty-four (24) Apple IIe microcomputers, one teacher at each of the grade levels 4, 5 and 6 had eight (8) microcomputers in the classroom. Instruction was managed so as to prescribe lessons and monitor student performance. Records were kept on student performance and indicated mastery or non-mastery of specific objectives.

Computer-Assisted Instruction (CAI)

The purpose of the CAI program was similar to that of the CMI-CAI program except floppy disk drives were used with stand alone microcomputers and computer-managed instruction played a less important role in comparison to the CMI-CAI program. Teacher management and control of access to the microcomputers was crucial in both programs. In almost all schools two teachers at each of the grade levels 4, 5 and 6 had four (4) microcomputers in their classrooms. Commodore 64 or Apple IIe microcomputers were used at a particular site.

Microcomputer Basic Skills Laboratories

A Commodore 64 CAI lab was set up in one school district using a Richvale network and a hard disk. Twenty-four (24) microcomputer systems were located in one room, and several groups of students were brought to the room each day for about 20 minutes of on task activity. A 30 unit Apple IIe lab using equipment similar to that installed in the CMI-CAI schools was installed in another school district and functioned in a similar manner as the Commodore 64 lab. An aide was used only in the Apple IIe lab.

Basic Skills Testing and Prescriptive Program

Under the direction of Tom Bishop from Arkansas State University, two school districts implemented an Arkansas Basic Skills Mathematics Testing Program for the microcomputer. A management system and CAI program were included in the project. The program, Computer-Assisted Instruction Management, is referred to as C-AIM.

The primary purpose of the C-AIM program was to improve the instructional management of mathematics instruction through the use of microcomputers. Students' progress is evaluated using tests correlated to Arkansas Basic Skills Objectives. Prescriptions are then given using CAI.

This C-AIM mathematics program has been disseminated to twenty-eight elementary schools in twenty-two school districts in seventeen counties. There are approximately 168 teachers and 4000 students involved in grades 3-6.

Related Activities

In addition to implementing and monitoring pilot programs, the Commission has provided leadership in several other areas vital to long range goals. These activities include:

1. The development of resource materials and guidelines for grades 3-8 and 9-12 for Arkansas school districts
2. Leadership conferences on in-service education related to microcomputer instruction
3. Writing conferences to develop course outlines for three levels of in-service training
4. Assistance in establishing a summer institute to train consultants in the area of microcomputer instruction
5. An annual survey of school districts to maintain data on the status of program development and hardware acquisition
6. A feasibility study and development of comprehensive microcomputer reading, language arts and science courseware for general distribution to Arkansas school districts
7. A contract to develop a method of selecting high quality courseware to be recommended for use by Arkansas school districts. A recommended courseware list has been developed and made available to Arkansas schools for use in selecting basic skills courseware including mathematics, reading, language arts, social studies and science. The list is being updated with a supplement published every six months.
8. The securing of grants or donations of microcomputer systems from Apple, Commodore, IBM, Radio Shack and Sperry which provide the basis for a teacher in-service training center and software review lab at the Little Rock IMPAC office.

IMPAC PROJECT SCHOOLS
1983-85

Project Type	School District	# of Teachers
CMI-CAI	Pulaski County	3
	Fayetteville	3
	Fort Smith	3
	Monticello	3
	Vilonia	3
CAI	Conway	1
	Corning	6
	Benton	2
	El Dorado	6
	Gould	2
	Gurdon	6
	Hot Springs	6
	Mammoth Spring	6
	Marshall	6
	Stuttgart	6
	South Mississippi County	6
	Texarkana	6
	Waldron	4
CMI-CAI Labs	Pine Bluff	10
	Little Rock	10
C-AIM	Jonesboro	6
	West Memphis	4

MINICOMPUTER AND MICROCOMPUTER INSTRUCTIONAL DELIVERY SYSTEMS

Instructional Delivery Systems can be divided into four levels.[33,34] IMPAC research relates to Level I and Level II instructional delivery systems. However, the Arkansas Commission on Microcomputer Instruction is monitoring programs at all four levels.

Level I

Personal computers in a stand-alone mode using a floppy disk represent a Level I CAI instructional system. These systems can be purchased over a period of time with only moderate budget constraints. The computer systems range in cost from $650 - $2,000 and are being used effectively for CAI in basic skills areas, introductory computer science courses, computer programming, word processing and for application software activities.

CMI-CAI software applications are limited due to the large number of floppy disks needed. Sufficient quality supplementary basic skills software using drill, practice and tutorial options and single concept and applications software is expected to continue to be available to justify the continued Level 1 systems. However, the search for such software requires innovative techniques that avoid duplication of effort by hundreds of classroom teachers and administrators. Teachers and students can profit immensely by working with Level I systems until higher level systems can be purchased and implemented. Such systems should be viewed as having a five (5) year life.

Level II

Stand-alone computers networked to a disk file server - usually a hard disk - represent a Level II CMI-CAI system. Networks such as the Corvus Omninet connected to a 45+ megabyte hard disk provide the capability needed to serve 25-30 stations with courseware in mathematics, reading, language arts and science that covers most of the Arkansas Basic Skills grades 3-8. Such a system can also include a management system that provides teachers with sufficient information to manage instruction without getting involved in extensive testing and evaluation procedures. The teacher, as a decision maker and classroom and instructional manager, is worth a "lot of megabytes" and in some sense of the word is software and hardware that makes complex decisions and relates to a data base far exceeding that of any computer system.

Level II systems are more expensive than Level I systems and do strain the budget. However, with sufficient software, a well trained teacher aide, in-service education on the system and good software and hardware maintenance, a Level II system can provide an instructional delivery system that can be mass produced, implemented in hundreds of schools and generate the type of instructional activities that justify the system as a permanent fixture in education. It is assumed that the technology will improve and that high quality network software will increase in availability and decrease in cost.

Classroom networks can be connected to mainframe computers and provide data for reports to parents, teachers and administrators. This process is critical to the long range effectiveness of Level II systems. It is very desirable that Level II computers have networking and interfacing capabilities. A computer shake out is on the horizon and new generation systems of the winners will be designed to provide more sophisticated instructional delivery systems.

Level III

Professional systems such as the one developed by WICAT have greater storage capacity and relate to a minicomputer system with more sophisticated code, audio and graphics that provide instructional strategies not available on Level II systems at the present time.

Supporters of Level III systems that view them as the light at the end of the tunnel provide some strong arguments for the quality of the instructional delivery system that justify its cost. Authoring systems that can develop courseware at 1/3 the cost in 1/2 the time is more than a promise. It is also correct that reading and mathematics programs grades 3-8 can require as much as 150 megabytes of storage. How much better these programs are than programs developed for 45-120 megabyte hard disk is still an open question. Big may be better but cost becomes a significant factor quickly.

Computer managed instruction, computer adaptive testing, computer adaptive learning, monitoring student learning curves and computer based administration are what really separates a Level III system from a Level II system. Educators must encourage the continued research and development of these educational tools. Most schools in Arkansas cannot afford the cost of Level III systems without a total reordering of educational priorities. This is unlikely since the compelling arguments are not being expressed and significant progress is still being made with Level I and Level II systems.

Level IV

Mainframe computers with terminals relating to sophisticated administrative and communication packages are not currently cost effective for education. Eventually Level II or Level III systems will be coupled with Level IV systems to provide educational networks from the classroom to the State Department of Education. Educators should be grateful to the early explorers in CAI and CMI, those instrumental in developing the Stanford based CCC and University of Illinois based PLATO programs which related to mainframe computers. Both of these efforts are still viable forces in basic skills education as well as specialized training of military and industrial personnel.

Any mainframe computer manufacturer that is also involved in developing Level I, Level II or Level III educational systems is a candidate for assuming the leadership role of developing the first Level IV system designed to address most of the currently perceived needs and applications of a combined instructional and administrative system.

SURVEY OF LITERATURE

A survey of literature related to research studies since 1960 indicates that three types of research are relevant to IMPAC: research that provides direction for improving instruction related to classroom and school level variables; research that is directly related to improving instruction in mathematics, reading and language arts in which traditional instructional methods were used; and research in which instructional improvements involved technology, particularly computers and computer-assisted and computer-managed instruction.

Classroom and School Level Variables Related to Improving Basic Skills Instruction

Nina Gupta in an extensive summary of research related to classroom and school level variables has highlighted the significant findings that have been reported by researchers over the past few years.[30] Other research studies confirmed Gupta's conclusions and in some cases provided more specific conclusions. The following list is representative of the conclusions reported in the summary of findings from a variety of sources.[6,7,17,19,42]

1. Overall, no consistent results have been found with respect to the impact of class size on academic achievement. Teachers have developed effective strategies for working with classes of moderate size (20-28 students).

2. Individual competition provides the most consistent positive effects as a reward structure within the classroom.

3. In general, students tend to learn best what their teachers emphasize most. Therefore, priorities about what should be emphasized are extremely beneficial.

4. Providing teachers with immediate feedback regarding their teaching styles may lead to improvement, not only in teacher behaviors, but in student behaviors as well.

5. The leadership style of the principal is crucial in determining the effectiveness of the school as a whole. It is beneficial to ensure that the school principal has the process skills related to communications, curriculum development, instructional evaluation and stimulation of professional growth and development within the staff. Some of the important elements in the instructional management process for principals include: selecting high quality people, providing instructional support and assuring that learning goals are in place, obtaining adequate resources to do the job, exercising quality control, coordinating activities and solving problems. Personal characteristics that are related to strong leadership qualities of principals include:

a high level of academic achievement in college, a high degree of interpersonal skill, motivation for public service and commitment of off-duty time to the job.[53]

6. The climate of the school should be open with ideas and information shared freely and evaluated in a constructive manner. The physical, procedural and social structure of the school should foster a feeling of belonging among students and staff. School climate is a predictor of achievement.

7. Principals and teachers should convey a clear academic mission to students and parents and actively elicit parental support.

8. Principals and teachers should hold high realistic expectations for students' achievement.

9. Principals and teachers in the elementary school should allot and use substantial blocks of uninterrupted time for the teaching of reading, language arts and mathematics.

In the context of classroom and school variables there are desirable components for an instructional system that can be clearly defined and identified. These can be described and measured as being present or absent during an instructional time period.

The Program for Effective Teaching (PET) developed by Madeline Hunter provides the basis for a teaching-learning model that has been developed to provide an orientation for teachers to IMPAC programs. Concepts related to effective instruction, classroom management and established principles of learning theory have been incorporated into the model. The following matrix indicates the relationship between good classroom instructional practices and IMPAC programs.

Model for IMPAC

(X) Applicable

	CMI CAI	CAI	C-AIM	IMPAC
Objective Based	X	X	X	X
Objectives at Appropriate Levels	X	X	X	X
Guided Activities (Immediate Feedback)	X	X	X	X
Diagnostic Questions	X	–	X	X
Involve Learner in Learning Process	X	X	X	X
Concept Development	X	X	X	X
Drill and Practice	X	X	X	X
Intermittent Practice	X	X	X	X
Problem Solving	X	X	X	X
Positive Reinforcement	X	X	X	X
Generate Overt Behavior	X	X	X	X
Knowledge of Results	X	X	X	X
Mastery Questions	X	X	X	X
Monitor and Adjust to the Learner's Style	–	–	–	–
Control of Learning	X	–	X	X
Storage of Records	X	–	X	X
Retrieval of Records	X	–	X	X
Transfer of Learning	–	–	–	–

Research Related To Achievement In Mathematics, Reading and Language Arts

Literally hundreds of research studies have been conducted in mathematics and reading education over the past 30 years. Regular issues of journals of educational research provide extensive research reports on specific topics and annually provide a list of research summaries including dissertation abstracts.

Research Related to Achievement in Mathematics

In preparation for this IMPAC research report, reviews of mathematics education research on five topics were studied: specific concepts and algorithms, problem solving, planning for instruction, the teaching-learning process, and attitudes and interest.[4,36,37,41,61,65,70,71,72,73]

Among the factors related to problem solving ability are: ability to note likenesses, differences and analogies; understanding of mathematical terms and concepts; ability to visualize and interpret quantitative facts and relationships; skill in computation, ability to select correct procedures and data; and comprehension in reading.

No general conclusion can be drawn from research regarding the relative efficiency of any one organizational pattern for mathematical instruction. Neither team teaching, departmentalization, self-contained classrooms nor any other organizational pattern, per se, increases pupil achievement in mathematics. Higher achievement in computation, problem solving, and mathematical concepts occurred regularly when more than half of the class time was spent on developmental activities, with the remainder on individual practice.

Within self-contained classrooms there is a teaching strategy that is most often associated with high achievement. It incorporates flexible grouping, unit planning and diagnostic evaluation. Computers in the classroom may enhance this instructional process through supplementary instruction coordinated with group activities. The CAI can easily relate to the unit being taught and reflect the results of diagnostic test.

Children appear to acquire mastery and understanding of mathematical concepts in steps or stages. Materials which are structured to guide children through various levels tend to promote retention. Achievement is enhanced when children are placed at the appropriate skill development level and interest is maintained in learning through knowledge of success resulting from immediate feedback. High self esteem resulting from setting and achieving goals and good physical and mental health are also critical factors. Intensive practice and cumulative review should be provided regularly to reinforce skill development. Guided discovery lessons and problem solving activities also enhance learning and should be infused into the curriculum on a regular basis.

There is evidence that fewer pupils are afraid of mathematics and more enjoy the challenge of mathematics today than was the case 25 or even 10 years ago. However, there is no consistent collection of research evidence to support the popular belief that there is a significant positive relationship between pupil attitude toward mathematics and pupil achievement in mathematics. However, there is a positive relationship between a teacher's attitude and her pupils' attitude toward mathematics.

Pupils dislike mathematics due to a lack of understanding of basic concepts and how to apply those concepts, poor achievement and general loss of interest in school. Those that like mathematics tend to do so because they have mastered the basic skills of arithmetic and find many exercises to be interesting, challenging and fun. Mathematics is viewed by a high percentage of students as a most useful subject with every day applications. However, the precision of mathematics, the dependency of new concepts on earlier sequentially developed concepts and lack of mastery of number facts and algorithms are sources of discouragement for some students.

Research Related To Achievement In Reading and Language Arts

Research related to methods of teaching reading and language arts is extensive and in many cases highly technical and related to general theories of learning and educational philosophies. There are, however, numerous studies related directly to the mechanics of teaching and characteristics of effective teachers as measured by student achievement.[3,5,8,12,31]

In general effective reading and language arts teachers:

1. target basic skills and try to insure that students are actually trying to master the skills

2. diagnose their students' needs and plan instruction on their findings

3. explain directly to their students by definition and example

4. provide varied and meaningful practice to insure mastery and transfer of basic skills

5. use flexible grouping

6. expect students to be successful in learning

7. are good classroom managers.

The criteria generally used by teachers to place students in reading groups include reading ability, general academic performance, work habits, and behavior and personality. The specific method used in teaching reading is usually consistent with or determined by the textbook series adopted by the local school district. Supplementary instruction through pull out or in class programs is generally available through special education and Chapter 1 programs that target low achievers or students with special needs.

This section is concluded with a description of the basic approaches to teaching reading so that the reader is reminded of the complexity of teaching reading and the difficulty of providing a "quick fix" for improving reading skills through CAI.

Approaches to Reading Instruction

Successful reading programs utilize more than one approach to the teaching of reading. This is due, in part, to the fact that not all children learn to read in the same way. Because of the varied learning styles of children most Arkansas classrooms use some combination of the following approaches to the teaching of reading.

1. Basal Approach. This approach uses basal readers, workbooks and related materials to teach a number of reading skills in a variety of ways. These skills include: auditory and visual discrimination; recognition of basic sight words; phonetic analysis; context clues; structural analysis; vocabulary; literal and interpretive comprehension skills. All standard reading series teach the same skills; the major difference is in the way skills are sequenced. Each Arkansas school must adopt and use an approved reading series.

2. Language Experience Approach. The emphasis central to this method follows from the belief that reading is best learned when reading instruction is based on the oral language of the children being taught. Children dictate or write stories which then become the basis for reading instruction. Some teachers use this method to teach early sight vocabulary. Others use it more extensively for a longer period of time.

3. Linguistic Word Structure Approach. This method uses word patterns as the basic unit of teaching. It is sometimes called the "fat cat" technique and is based on rhyming words or word families. No attempt is made to isolate sounds or break up words. Recently teachers have stressed more the use of these words in phrases and sentences in an effort to teach comprehension as well as decoding skills.

4. Auditory-Visual Method. In this method of teaching reading the letter is the basic unit of instruction. The student is first taught the sound-symbol associations. Later these associations are combined to form words. Some basal reading series use this method as one of the ways of teaching word recognition; others rely heavily on this method in an intensive phonics approach.

5. Programmed Approach. Programmed reading instruction is a highly structured set of materials which presents reading as a sequenced continuum of skills. Students may progress through the program at various rates, depending upon how quickly skills are mastered. Instruction may be presented in a book or on a computer.

The successful implementation of any approach to teaching reading depends on the classroom teacher. The key to good reading instruction is based upon matching the method of teaching to the learning style and the needs of the students.

Matching Basic Skills Objectives with Standardized Test Objectives

There are detailed studies that clearly indicate that conclusions drawn from research are often affected more by inappropriate evaluation instruments than research design. For example, the Stanford Achievement Test, Iowa Tests of Basic Skills, Science Research Associates Tests, Metropolitan Achievement Tests and Comprehensive Tests of Basic Skills relate to specific skills and the correlation with state or local objectives must be checked carefully to assure content validity.[2,23,63] Item distribution by concept or skill as measured by the percentage of test items has high variability. Therefore, it is likely that there can be significant discrepancies between the content a teacher presents to students and the content which is being tested on the standardized test administered. This may result in an underestimation of student achievement. Likewise, this observation is also true for reading and language arts tests.

The Elementary and Secondary Education Act (ESEA) was passed in 1965. ESEA funds helped encourage the development of educational programs for students from low income families. Legislation required that effective evaluation procedures be implemented to provide a national profile of the extent to which Title I funds were supporting programs that resulted in increased learning by educationally deprived students.[32]

Section 151 of the Education Amendments to ESEA in 1974 resulted in evaluation models that provided required uniform methods of evaluation. The norm-referenced model and the associated achievement test normal curve distribution equivalence table provided the student achievement profile tool. However, the three criteria used in selecting test items for a norm-referenced test (NRT); item discrimination, item difficulty and item content assured that NRT results in mismatches between what is being tested and what is being taught. This results in the elimination of items covering important topics or skills; for example, items that test good objectives but have low difficulty.

Minimum competency testing and the numerous court cases related to bias and content validity have led to the pseudo science of objective based or criterion referenced test construction and test item specifications which result in a high correlation between test results and student mastery of objectives. By using the SRA Basic Skills Achievement Series Test of which 90% of the objectives correlate to the Arkansas Basic Skills objectives, the IMPAC test results reflected student mastery of basic skills. The validity of this contention was crucial to the results obtained in IMPAC research.

Research Findings On Computer-Aided Instruction

Identification and review of some of the extensive research related to the use of Computer-Assisted Instruction (CAI) and Computer-Managed Instruction (CMI) has not only been a priority of IMPAC but also of other groups such as the Education Turnkey System, Inc. and The Association of Educational Data Systems.[9,57] Some of the research presented in recent publications by these two organizations and others has been studied and reviewed by IMPAC. In most cases, conclusions drawn were the same with only minor exceptions. This section treats only those studies that relate directly to IMPAC projects and the central mission of IMPAC and is not intended to be another report on the current status of research on computer related instruction.[11,13,16,18,22,29,35,38,46,50,51,52,60,67,68] From the outset it should be stated that some traditional methods of instruction not involving technology often result in higher achievement in basic skills at a lower cost. Methods such as reducing class size, pull out tutorial programs, instructional television, special teacher training programs and peer and cross-age remedial tutoring were examined. However, in order to compare various methods, cost effectiveness and educational effectiveness had to be equated. An attempt was made to address this matter but additional research is needed that exceeds the scope of IMPAC's 1983-1985 mission.

CMI applications require extensive training and involvement by participating teachers and principals. CMI programs especially developed to meet local needs for reporting to parents and testing and monitoring basic skills are moderate in cost, time consuming to develop and help teachers target specific objectives for review and remediation. One microcomputer system including an appropriate disk drive, monitor, printer and card reader or answer sheet scanner with associated CMI software can serve 12-40 teachers and be cost effective. A teacher's aide or central office secretary usually assumes the task of processing the test data each week and disseminating the results to the school principal.

CAI applications can be managed through stand alone computer systems without management or networked computer systems with management in several classrooms or a laboratory. The number of students per microcomputer system, classroom organization (self-contained, semi-departmentalized, departmentalized), objectives included in the courseware, time on task and classroom management procedures are some of the critical factors that determine the educational effectiveness of CAI instruction.

In 1976 G. V. Glass introduced the statistical procedure called meta-analysis.[24] The procedure gives a measure of relative effect of instructional procedures and supplies information on what factors contribute to the effect observed. The effect measure is simply the quotient of the difference in the means of the treatment and control group and the pooled standard deviations of the two sets of posttest scores. Several major reviews of research have been completed during 1980-85 in which meta-analysis has been applied. Average effect size (ES) related to CAI supplementary instruction in mathematics, reading and language arts in the elementary school for one of the typical studies is shown below:

Subject	Average Effect Size	Control Group %	Experimental Group %
Mathematics	.35	50 %	64 %
Reading	.15	50 %	56 %
Language Arts	.20	50 %	58 %
CMI alone	.10	50 %	54 %

It is possible to translate specific effect size into grade equivalency gain if there is sufficient data reported in a study. For example if $\bar{X}(E) = 6.64$, $SD(E) = 1.75$ $N(E) = 23$ and $\bar{X}(C) = 5.83$, $SD(C) = 2.00$ and $N(C) = 22$ then $SP = 1.77$ and $ES = (6.64 - 5.83)/1.77 = .46$. A difference of .81 grade equivalency was associated with an ES of 0.46. Therefore, in this case a difference of 0.62 in grade level gain would be required to produce an ES of 0.35. However, if SD(E), SD(C), N(E) and N(C) are given different values then an average grade level gain of 0.62 may be associated with a higher or lower value for ES.

COST EFFECTIVENESS BASED ON EDUCATIONAL RESEARCH

What does research say about how much a school district should invest in microcomputer instruction? Cost analysis related to four different methods of improving basic skills through supplementary activities has been reported in a study, Cost Effectiveness of Four Educational Interventions, supported by funds from NIE and published May, 1984.[45] The four interventions include: reducing class size, increasing the length of the school day, computer-assisted instruction and tutoring. In general, tutoring approaches were found to be the most cost effective, while reducing class size and increasing the amount of time devoted to traditional instruction were found to be the least cost effective.[26] Computer-assisted instruction ranked between these two extremes.[43,44]

For the purpose of this IMPAC study, the cost effectiveness of supplementary instruction was examined, using methods developed in the NIE study. Results were based on average gains (grade equivalence) in reading and mathematics resulting from an expenditure per student per year in each subject and reflect the Arkansas cost for educational service of $2344/student for 1984-85. The following table provides a summary of the results.

Cost Effectivness Per Student Per Subject
By Type of Instructional Intervention

Method	Cost Per Student Per Year	Average Grade Level Gain	
		Math	Reading
Tutorial (an extra 30 min/day)	$152	.5	.3
Reducing Class Size 30 to 25	$160	.2	.2
25 to 20	$200	.3	.3
Increasing Regular Instructional Time in the Subject By an Extra 30 min/day	$105	.1	.2
Computer-assisted Instruction (12-20 minutes/day)	$100*	.3	.2

* average cost over 5 year period

There is another approach to the cost effectiveness of computer-assisted instruction based on research studies over the past 22 years. There are numerous research studies that support the following assumptions. However, these statistics, as was the case with the statistics in the previous table, should be viewed as averages and extreme deviations may occur unless conditions are similar to those in schools from which the data was obtained. These assumptions form the basis for some generalizations that provide a good overview of the effect of CAI.

1. Seventy-five percent (75%) of the cost of education per student is related to the teacher and instructional materials.

2. Twenty-five (25%) of the school day is devoted to reading and language arts instruction and fifteen percent (15%) to mathematics instruction.

3. Ten percent (10%) of the innovative or supplementary effect of computer-assisted instruction is related to the Hawthorne effect even after one year.

4. When basic skills instruction is supplemented with CAI, the average grade level gain in mathematics is .3 and the average grade level gain for reading and language arts is .2. It is assumed that students are in grades 4-6, on task 12-20 minutes each day in a cycle of 5 days in 10 and that the class average gain is typically 1.0 years per year with 50% of the students initially below grade level.

The following application of the information in 1, 2, 3 and 4 can be correlated with the IMPAC application of the NIE study and IMPAC's findings related to the cost and educational effectiveness of CAI.

If the cost of education per child in Arkansas in 1985 is $2364, then $2364 x .75 = $1773 is the average instructionally related cost for all subjects. $1773 x .15 = $266 is the average cost of mathematics instruction for which the average gain is 1.0 years. $266 x .30 = $80 is the average cost to improve .30 of a grade level. $80 x .90 = $72 is the average cost that could be attributed to CAI microcomputer instruction. This suggests that cost effectiveness for CAI is $72 per student in order to obtain an average grade level gain of 0.30. An equivalent figure using the methods developed in the NIE study and equated to Arkansas cost for educational services is $100 per student. If CAI reading and language arts is treated independently of the cost of mathematics CAI for the same classroom, then the cost would be $2364 x .75 x .25 x .20 x .90 = $80. An equivalent figure using the methods developed using the NIE study and equated to Arkansas costs for educational services is $100 per student.

If a district implements a CAI mathematics program in a self-contained classroom with 24 students and uses 4 microcomputers 180 minutes out of a 360 minute school day, then only 2400 minutes of the 7200 minutes available on 4 microcomputers in 10 days will be required to meet the needs of the students on an every other day basis. Therefore, 4800 minutes or twice the time period needed for reading instruction could also be met with the same hardware. The additional cost for adding reading and language arts would be the cost of software and in-service. Based on the IMPAC study the additional cost would be approximately 23% of the CAI mathematics program cost. The additional four year cost is 25% of the first year cost.

If this reasoning is followed the estimated cost effective figure for CAI mathematics, reading and language arts for Arkansas is [$100 + $100 (.23)] = $123 for a CAI stand-alone program for each student over a five year period. The previous formula provides the estimate [$72 + $72 (.23)] x 1.25 = $111 for each student over a five year period.

The average cost per student for an IMPAC CAI mathematics, reading and language arts program over a 5 year period is estimated at $80, slightly less than the $111-$123 research based figures. This is due to bidding and group purchases coupled with the fact that assumptions A through D concerning CAI are largely based on minicomputer systems. It is clear from IMPAC research that the cost of educationally effective CAI programs range from $80 to $175 per year per student depending on whether microcomputer, networks or minicomputer systems are used. It is also clear from IMPAC's research that microcomputer CAI programs generally provide flexibility in software choice but utilize CMI in a minimal way. Most minicomputer systems deliver extensive software and include CMI record keeping features. Either approach appears to be feasible. The IMPAC network CMI-CAI program was designed to approximate the mini-computer systems at less cost. The $104 cost per student per year for the IMPAC CMI-CAI program is in line with the cost of microcomputer CAI and minicomputer CMI-CAI programs when educational effectiveness is considered.

Research over the past 24 years has centered on CAI and CMI-CAI with little attention given to isolating the effects of CMI. A detailed review of 73 research reports published during 1962-85 on computer related instructional activities, selected from abstracts on 380 studies, suggests some common threads among the conclusions drawn by researchers.

In particular, nine generalizations about CAI emerge from the research conducted nationally during the period of 1962-85 with enough regularity to inspire confidence in their use.

1. CAI is most successful in helping learners attain clearly specified objectives, especially in the basic skill areas.

2. CAI saves significant amounts of time over "conventional instruction", as much as 20 to 40 percent.

3. Retention rates following CAI are at least as good as, and often better than, retention following conventional instruction.

4. Students have positive attitudes toward good CAI programs and dislike poor programs, especially those over which they have no control.

5. The appropriate instructional time for CAI from a learner, administrative and classroom management standpoint is 12-20 minutes on task four days a week in a given subject.

6. Tutorial - drill - practice CAI are effective types of courseware. Courseware incorporating both Behavioral and Gestalt psychological principles increase effectiveness.

7. Achievement gains in reading are about 70% of the gains in mathematics when instruction is supplemented with basic skills CAI.

8. Supplemental - CAI seems to result in greater gains more frequently than CAI lessons substituted for regular lessons.

9. Students using computers have positive attitudes toward ease of use and about learning through the use of a computer or terminal.

Positive attitudes about self-pacing, opportunities to correct errors in a non-threatening environment and immediate knowledge of results are features of quality CAI courseware which provide motivation that contributes to the learning of basic skills.

In most of the 73 studies the investigations focused on teacher instruction supplemented by computer-assisted instruction. It is clear that technology can be used to help make teachers more effective. Microcomputers can transmit information, teach certain skills and help students solve problems. In doing these things it can free teachers from being dispensors of information and permit them to manage and coordinate instructional activities.

ANALYSIS OF REVIEWS OF RESEARCH STUDIES

This section is devoted to the analysis of recent summaries of research studies. Roblyer has developed a synthesis of 12 previous reviews of research that includes numerous studies on instructional computing published between 1972 and 1985. Blaschke and Abrams dealt with 15 studies related mostly to CAI but to some extent to CMI. Tolman and Allred organized their summary of research according to the following topics: (1) availability of use, (2) classroom applications, (3) major curriculum applications, (4) exceptional children, (5) attitudes and motivation, (6) contributions of large computer systems, and (7) future issues and concerns. The research report issued by the National Commission for Employment Policy in April, 1985 covered such topics as CAI, CMI, administrative applications, problem solving applications and computer literacy and computer programming. One section of a mathematics education research report published by the Association of Supervisors and Curriculum Development summarized numerous studies related to CAI and CMI. There were a total of 959 bibliography entries listed in these five reports representing approximately 850 different studies or summaries of studies.

Relevant Conclusions Drawn from the Five Reviews

The Computer and Education
(National Educational Association, 1984).[66] The general conclusions drawn include:

1. CAI can assist in attaining specific instructional objectives

2. Substantial savings (20 to 40 percent) in time can be achieved for learning as compared to "conventional" instruction

3. Retention following CAI compares well with retention following conventional instruction

4. Students react positively to well designed CAI programs

5. Studies point to a significant enhancement of learning in instructional environments supplemented by CAI, particularly in mathematics

6. Computer assisted instruction serves as a vehicle for computer literacy

7. Potential for computer use by both gifted and handicapped students appears to be great

8. One of the computer's most valuable potential contributions is its ability to motivate and keep student interest high. Student reaction toward certain subjects has been positive in nearly all cases as a result of computer use.

9. The task of controlling the quality of software is of utmost importance

10. Illegal duplication of software and the lack of clarity about software protection rights is a major problem that must be addressed at the local, state, regional and national levels

11. Networking of several computers to a single hard disk drive with CMI-CAI software is rapidly gaining popularity in many parts of the United States

12. Extensive teacher in-service needs exist because the majority of current faculty members in educational institutions completed their formal training before the advent of the computer in the school.

Mathematics Education Research
(Association for Supervisors and Curriculum Development, 1981).[20]

Much of the information in the section on computer applications related to research on the Computer Curriculum Corporation (CCC) and PLATO Program. Basic conclusions included:

1. Time children spent at CAI terminals was positively related to achievement. Ten minutes per day, five days per week, for a total of 1,500 minutes per year is the optimum time students should spend on CAI where CAI is used to supplement regular instruction.

2. There is substantial evidence that actual achievement gains exceeded expected gains based on knowledge of students' past performance.

3. Attitudes of students and teachers toward CAI were positive.

4. The effective use of CMI for diagnosis and prescription of learning activities requires extensive teacher involvement in developing a generic management system into one that specifically meets local needs. This effort could take as long as three years to reach maturity and then must be carefully monitored. Content and item writing specifications that lead to reliable tests with content validity provide a basis for the process.

5. Attitude alone is not an adequate measurement of the effectiveness of CAI.

6. Computers in the classroom must be managed by the teacher and not support personnel. CAI and CMI extend the teacher's ability to assess student performance, target certain objectives for remediation and provide enrichment in problem solving activities.

Computer Assisted Instruction (CAI): The Bottom Line
(The International Communications Institute Association, 1985).[9]

This study provides a non-technical review of some of major studies appearing in the bibliography of the other four publications treated in this section. Conclusions drawn are of major importance because the report was prepared by a National Education Consulting firm, Education TURNKEY Systems, Inc. which has been very accurate in predicting future trends in educational technology over the past three years.

1. CAI seems most effective for student achievement at the elementary level. Students in classes using supplementary CAI instruction generally performed at the 63rd percentile when compared to the control group which performed at the 50th percentile.

2. Student attitude toward the use of CAI is very positive.

3. Students master some objectives using CAI in 33% - 40% less time then with conventional instruction.

4. Quality courseware that targets specific objectives should generally include the following features:

    a. Control of the program by the student with adequate help features

    b. Feedback and rewards when appropriate

    c. Monitor students progress

    d. Allow for easy operation

    e. Have tutorial, simulation and drill and practice features with occasional game formats for some lessons.

5. Implementation of CMI systems has to be preceded by in-depth training on the part of all instructional staff, principals, and key administrators, particularly in the area of individualized instruction. CMI can be a vehicle for prescribing CAI for the remediation of objectives identified through the testing features of CMI. Progress in basic skills achievement can be monitored and reports generated using comprehensive CMI programs. However, the process is time consuming and test items must be based on item specifications related to state basic skills tests.

6. Flexible scheduling, good classroom management, comprehensive CAI packages, an effective in-service training program for teachers and good vendor support for hardware and software are important factors in the success of CAI supplementary instruction.

Uses of Computers in Education
(National Commission for Employment Policy, 1985).[15]

This report, more general than the others, provides a good overview of the current status of computers in the schools in several areas other than CAI and CMI applications. For example, the historical growth of the number of computer in schools: 30,000 - 1981; 600,000 - 1984 and 1,000,000 - 1985, and 3,000,000 - 1990. Administrators tend to use a microcomputer system for one specific purpose - accounting or word processing or communications with a data base through a modem. Urban and rural differences and the equity issue are discussed. However, the major conclusions drawn which directly relate to the IMPAC study and future trends include:

1. State level development of policies and procedures for implementing computer/communication technology projects

2. Massive in-service training programs related to individualized instruction and classroom management

3. Courseware development that builds upon advancing technology to meet school curriculum needs

4. Convergence of microcomputers, telecommunications, interactive video disc, networks and management systems.

Conclusions about the effects of Computer-Based Education include:

1. CAI provides students with individualized instruction which they often fail to receive in a large classroom setting

2. The subject areas where CAI is most effective are science, foreign languages, mathematics, reading and language arts

3. CAI is effective with low achievers but requires more time on task than with average or above average students

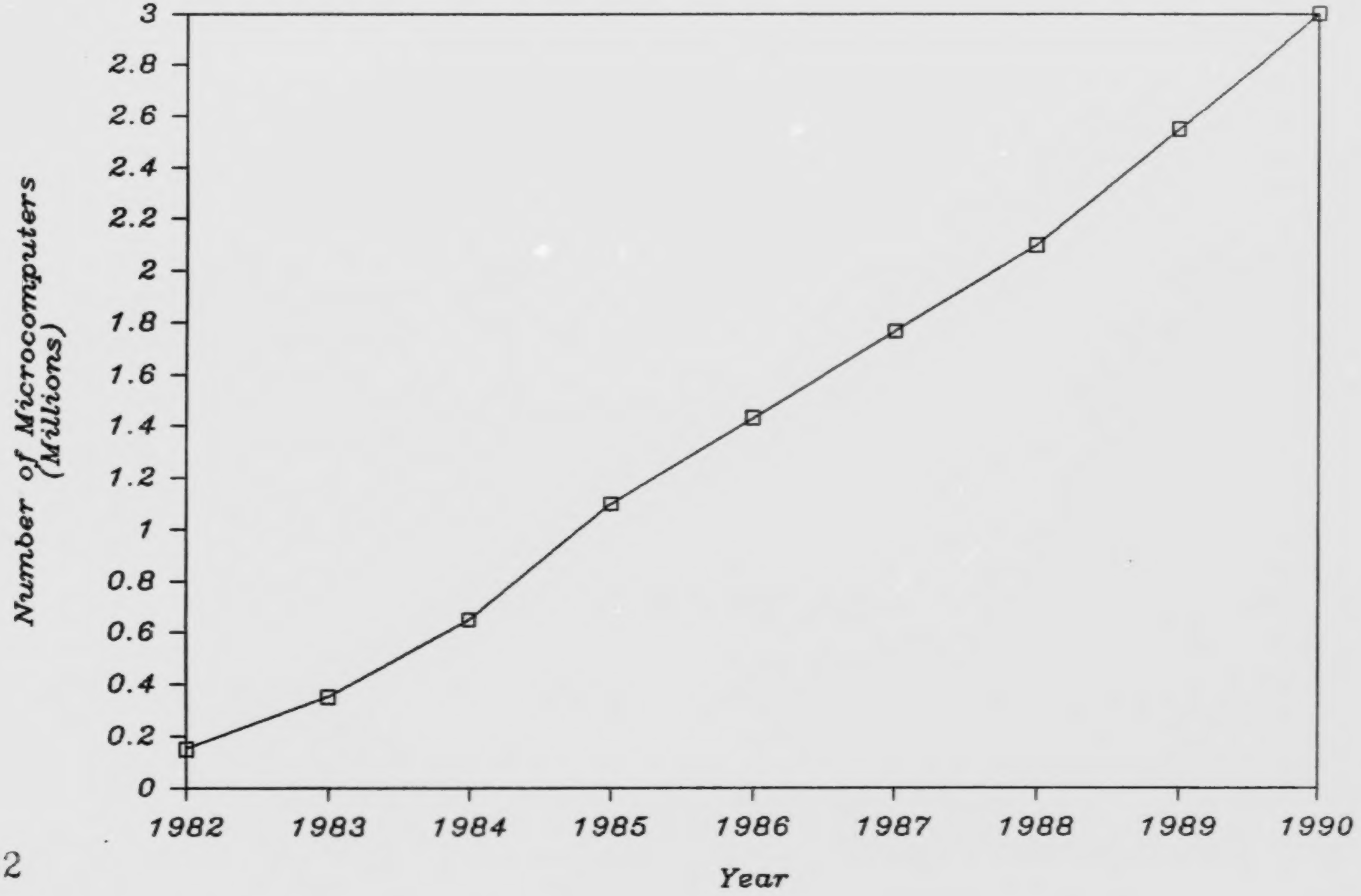
4. CAI is most effective when it is used as supplementary instruction

5. Teachers feel that CAI is effective especially with low achievers

6. There is evidence that teachers are increasingly interested in using CAI as a replacement for some of the traditional supplementary materials

7. Student attitudes toward CAI, highly positive in 1984-85, is expected to decline as home and school use of CAI increases at a faster rate than the quality of courseware increases

8. Computer literacy is being replaced by technology literacy. The notion of computer literacy is expected to rapidly disappear as educators and policy makers recognize that the computer is only one tool enhancing productivity in the information age. Applications software will increasingly be integrated into regular subject matter offering students tools for problem solving


Number of Microcomputers in Schools

9. Most policy making officials within school districts are interested in using computers effectively either to increase or monitor student performance or to save time and paper work by staff. However, most of these officials are not aware of the conditions under which these programs are most likely to be successful

10. State and Federal policy makers are showing an increased concern for the effective use of technology in education and are seeking ways to avoid duplication of efforts and waste. Programs with Federal funding under Chapter I, Chapter II, Special Education and state supported projects will be more closely monitored during the next few years.

Measuring the Impact of Computers in Instruction
(Educational Data Systems, 1985).[57]

A review of twelve reviews of research on computer instructional applications is provided in detail by Roblyer. Five of the reviews were completed during 1975-80 using traditional +, −, = or significant differences statistical techniques. The author refers to these as per-meta-analysis reviews of research. Seven of the reviews were completed during 1980-85 using meta analysis.

Meta-analysis is a statistical procedure developed by Glass.[25,27,28] It provides a method that allows for analysis of results obtained in studies where differences in means achieved by control and experimental groups and reported in terms significant or nonsignificant T or F values or +, −, or = differences are treated as data. The method uses the concept of effect size (ES) where ES is defined as

$$ES = \frac{\bar{X}_T - \bar{X}_C}{SD_P}$$

$\bar{X}_T$ and $\bar{X}_C$ are the treatment and control group means assumed to be comparable due to an appropriate design or the use of Analysis of Covariance. SD_P is the pooled standard deviation obtained by using V_T and V_C and N_T and N_C, the associated variances and sample sizes. It is necessary that $F = V^2{}_T/V^2{}_C$ not be statistically significant for an appropriate level.

Meta-analysis seems to oversimplify the analysis of data from numerous studies because of the lack of commonality of research designs and measures of achievement. Common systematic bias tends to produce results in a single direction. Studies tend to be published only if + or = results are obtained. However, even the critics of meta-analysis feel that the mathematics theory associated with meta-analysis justifies the technique especially when specific common criteria are met by the studies included for meta-analysis. ES values are more meaningful than specific numerical differences or +, −, = results. However, the lack of precise linear relationships between ES and grade level equivalence makes interpretation by teachers and administrators difficult. The summaries of the pre-meta analysis reviews seem to support the following conclusions:

1. Larger gains from CAI or CMI-CAI occur more frequently in elementary grades

2. Equal to and a significant difference in achievement gains between treatment and control group means are prevalent

3. Supplementary CAI seems to result in greater gains more frequently than substitute CAI

4. Factors positively affected by CAI and CMI-CAI are reduced learning time and student attitudes toward instruction and computers.

The summaries of reviews subjected to meta-analysis seem to support the following conclusions:

1. The highest effect sizes are found in elementary grades.

2. Supplementary CAI and CMI-CAI results in greater effects than replacement CAI or CMI-CAI.

3. In the elementary grades, younger and low ability students learn comparatively better from drill and older higher level students appear to profit more from tutorial type CAI.

4. Mathematics basic skills seem to be mastered more readily from computer-based instruction than reading/language arts basic skills.

5. Although computer based methods of supplementary instruction tend to show positive or equal gains, other non-computer strategies such as peer group or adult tutors, instructional television and teacher-inservice training in which improved methods of instruction and classroom management are emphasized also produce significant results. These results often are better than those produced using computer based instruction.

6. Studies related to the effect of CMI when combined with CAI are limited and cannot be generalized. CMI alone seems to result in ES values up to 15% -20% of those achieved by using CAI tutorial and drill and practice programs.

Verbal analogies, inductive/deductive reasoning, logical reasoning and problem analysis are the four factors usually studied in attempting to determine the effect of certain computer activities such as Logo or real world simulations on problem solving ability. Specific problem solving activities of one type do not seem to transfer to new dissimilar situations. Experience with identification of a problem, brain storming, evaluating specific hypothesis and interpreting results still provides results equal to those using computer technology. It is likely that a general education program which includes knowledge of problem solving techniques in one or two subjects and some of their supportive disciplines will provide the best basis for problem solving. One can be confident that computers will increasingly be used to generate more problem solving activities in which a class can be engaged. The computer will be used as a problem solving tool and report generator of summaries and conclusions of problem solving activities. Illustration of problem solving techniques for instructional purposes is a very appropriate function of computers.

In general, to solve a particular type of problem one must have a good knowledge base in areas related to the problem situations. The vocabulary and symbolic language required to properly explore the essence of the problem is often critical. Common sense judgments as to the cost and time restraints on proposed solutions often come only after years of experience. Computers can help one acquire these skills at an accelerated rate. However, several techniques of teaching problem solving seem to be equally effective and deficient.

Tables of ES Values
Elementary School Grades

(Comparisons subject to extreme deviations unless instructional conditions are similar to those in the underlying studies.)

Supplementary CAI-CMI/CAI*		ES	Percentile (50% control group)
Elementary level overall achievement		.40	66%
Elementary level achievement--Reading/Language Arts		.20 - .35	58 - 64%
Elementary level achievement--Mathematics		.35 - .45	64 - 67%
Student attitudes toward computers		.62	73%
Student attitudes toward instruction in the subject		.12 - .19	55 - 58%
Retention		.17	57%
CAI alone		.40 - .47	66 - 68%
CMI alone		.07 - .14	53 - 56%
CMI-CAI		.40 - .50	66% - 69%
Reducing Class Size:	25 to 20	.05	52%
	25 to 15	.15	56%
	25 to 10	.25	60%
Peer and cross-age remedial tutoring		.40	66%
Special inservice teacher training programs		.50	69%
Replacement CAI-CMI/CAI**			
Elementary level mathematics		.22	59%
Elementary level reading/lang. arts		.15 -.17	56 - 57%

*Supplementary CAI, CMI-CAI refers to a regular instructional program in which students achieve at the 50th percentile but usually show gains as indicated in the table by using supplementary CAI, CMI-CAI on a regular basis.

**Replacement CAI or CMI-CAI is the actual instructional program which usually shows gains as indicated in the table above the 50th percentile.

ADAPTATION OF SUPPES' MODEL OF AN INDIVIDUAL'S LEARNING CURVE

Any researcher that regularly communicated with mathematicians, statisticians, numerical analysts and computer scientists that are familiar with CAI and CMI-CAI research over the past twenty years will be aware of and have respect for the work of Patrick Suppes. Since 1975 Suppes has often spoken and written about his concern for global research studies that are based on averaging and make use of such statistical techniques as regression and analysis of variance.

In 1976 Suppes showed that an individual's progress through curriculum (called the learning trajectory) can be described by the family of curves.[62]

$$y(t) = bt^{k} + c$$

$y(t)$ = student's grade placement

t = amount of time spent in the curriculum

b and c are individual parameters estimated and refined as student progress is monitored

k = parameter for a particular curriculum. Suppes assigned .5 as the value of k for the CCC curriculum

from $y(t) = bt^{k} + c$ and its first and

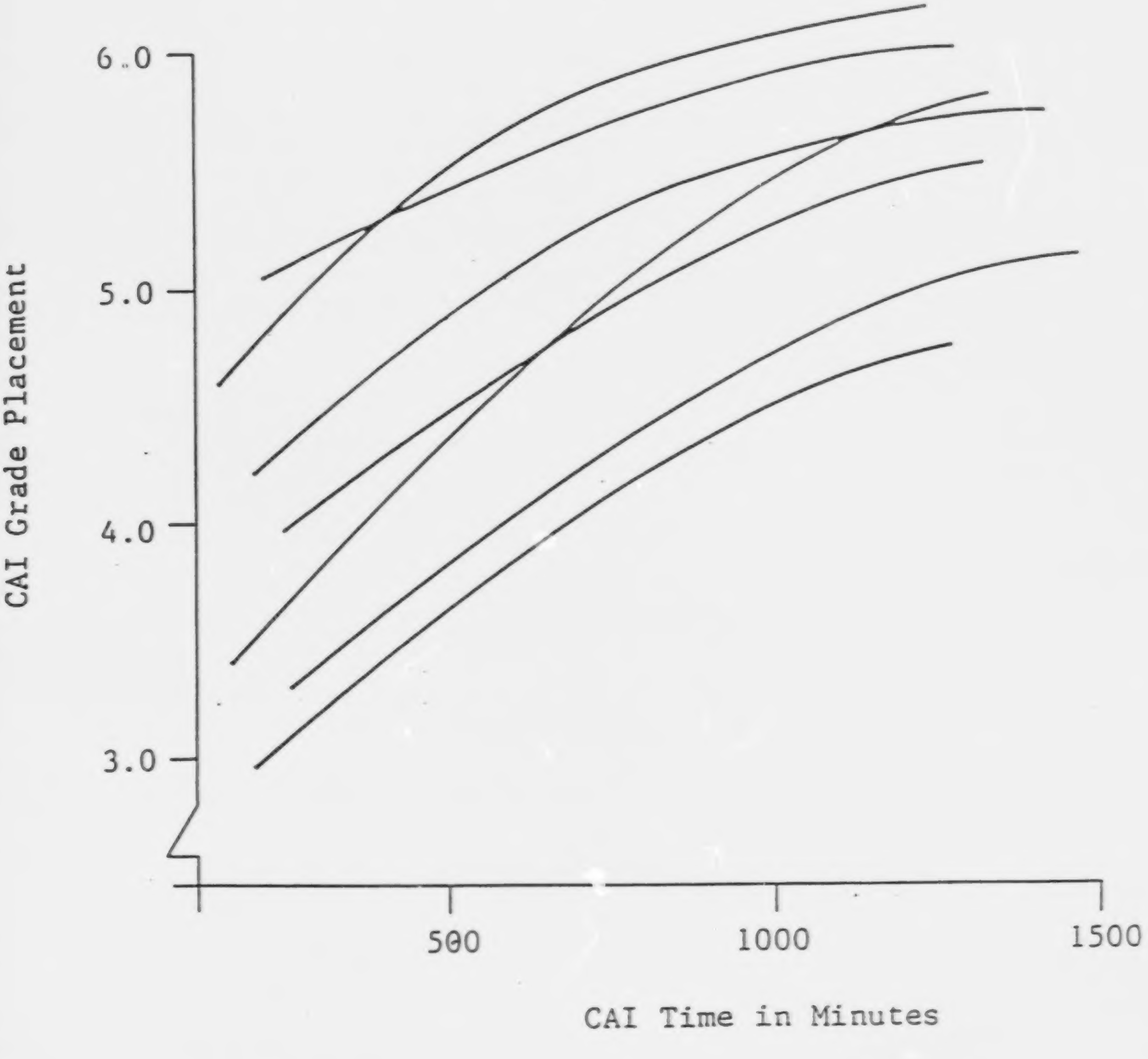
second derivatives $y'(t) = kbt^{k-1}$

and $y''(t) = k(k-1)bt^{k-2}$, more precisely

$$y'' = \frac{(k-1)y'(t)}{t}$$

It is easy to see that not only does the individual have a unique learning curve determined by b and c but the rate and acceleration of progress through the curriculum is unique for each individual because the function also contains the parameter b. However, the acceleration is proportional to the rate and inversely proportional to time, and the relationship between acceleration and rate of learning depends on the curriculum parameter k and not on either of the individual parameters.

This micro analysis of individual learning curves reveals that the relationship between time and grade level gains is not linear. Individuals proceed through the curriculum with distinct learning rates and accelerations. The amount of gain per unit of time differs for each individual. Also, regardless of various controls each student receives a different amount of CAI during a semester or academic year. The following graphs depict different learning curves for various members of a class placed initially through testing at an appropriate beginning point in the CAI lessons.



Individual learning trajectories through CCC's elementary mathematics curriculum.

Global analyses do not consider all of the relevant factors. In fact establishing the y intercept c which represents the appropriate placement in the curriculum at the beginning of the year, is crucial in maximizing the effect of CAI and CMI-CAI over the interval $t_0 \leq t \leq t_n$. Reported average gains in a study do not represent the results based on an average learning curve but rather represent the average of the values of $y(t_n) - y(t_0)$ for each student where t_n is the amount of time devoted to the curriculum and $t_0 = 0$, the beginning time. Furthermore, these differences are greatly affected by proper initial placement in the curriculum and the consistency with which the student is on task 12-20 minutes each day with a CAI lesson correlated with basic skill objectives.

Since the IMPAC study included numerous classes at a given grade level with the same curriculum and different amounts of time on CAI, a function of the form $y(t) = bt^k + c$ was generated to utilize the Suppes' model. The software related to a minicomputer CMI-CAI mathematics curriculum or a Corvus-Apple 45 megabyte network CMI-CAI mathematics curriculum could have built in routines to mathematically and statistically monitor an individual student's learning curve. Such a design is now being investigated by IMPAC for use in the evaluation of junior high school basic skills labs being implemented during 1985-86.

A similar model based on the multivariant function

$$y(t_1,t_2) = a(t_1)(c_1t_1)^{f(k_1)} + b(t_2)(c_2t_2)^{f(k_2)} + c$$

is presently providing a theoretical model for mathematics group data results achieved in the IMPAC study. The variables and their domains are defined as follows:

t_1 = amount of time a student is on task with CAI

t_2 = amount of time a student is on task with instruction related to the basal program

k_1 = the curriculum constant representing a measure of the correlation between CAI objectives and test objectives

k_2 = the curriculum constant representing a measure of the correlation between objectives treated in regular instruction and test objectives

c = a measure of the student's initial grade level placement

$t = t_1+t_2$

$$y_1(t_1) = (\frac{1900}{16000000} t_1 - .0870) (\frac{154}{220} t_1)^{\frac{1}{2}k_1^2}$$

$$y_2(t_2) = (\frac{1019}{16000000} t_2 - .2113) (\frac{80}{220} t_2)^{(k_2-.7)^2+.23}$$

The domains are restricted to real number closed intervals.

$$1100 \leq t_1 \leq 1500 \qquad .50 \leq k_1 \leq .70$$

$$4400 \leq t_2 \leq 6000 \qquad .50 \leq k_2 \leq .90$$

This model suggests that $t_1/t_2 = .20$ maximizes learning. $E[y(t_1,t_2)]$ and $V[y(t_1,t_2)]$, the expected value and variance obtained from the probability density function associated with the experimental data closely approximate the average gains and variability among these gains obtained independent of the model.

There is a second model of importance when one considers the mix of CAI with regular instruction compared to regular instruction. For example, if students are involved with CAI 1200 minutes and regular instruction for 5600 minutes and the measure of the correlation between CAI objectives and test objectives is $.50 \leq k_1 \leq .70$ and the correlation between regular instructional objectives and test objectives is $.70 \leq k_2 \leq .90$, then how would the results obtained compare with the results from regular instruction for 6800 minutes and $k=k_2$? The following model provides a basis for that comparison.

$$y(t) = \left(\frac{175}{16000000}\ t + .0699\right) \left(\frac{69}{220}\ t\right)^{(k_2-.7)^2} + .23$$

The models provide a way to view instructional mixes of CAI with regular instruction and are not predictive devices. Numerous variables have been left out and this model overly simplifies the complex nature of teaching and learning. From 9000 minutes available in 36 weeks of daily 50 minute periods for mathematics instruction available in grades 4-6 one must deduct the time lost for holidays, spring vactions, special events, etc. This was calculated to be 1700 minutes leaving 7300 minutes for instruction. To be even more realistic a time of 6800 minutes was used as class time for regular instruction in mathematics during an academic year. This time was used in considering the results generated from the model.

CAI Effect $y_1(t_1)$
k_1 Curriculum Correlation

t_1 Minutes	.50	.55	.60	.65	.70
1100	.10	.12	.14	.18	.22
1200	.13	.15	.19	.23	.29
1300	.16	.19	.23	.28	.36
1400	.19	.22	.27	.34	.43
1500	.22	.26	.32	.40	.50

$$y_1(t_1) = \left(\frac{1900}{16000000}\ t_1 - .0870\right) \left(\frac{154}{220}\ t_1\right)^{\frac{1}{2}k_1^{2}}$$

Regular Instruction Effect $y_2(t_2)$
(with time allocated for CAI)
k_2 Curriculum Correlation

t_2 Minutes	.70	.75	.80	.85	.90
4400	.38	.38	.40	.44	.51
4800	.53	.54	.57	.62	.71
5200	.68	.69	.73	.81	.92
5600	.84	.85	.90	1.00	1.14

$$y_2(t_2) = \left(\frac{1019}{16000000}t_2 - .2113\right)\left(\frac{80}{220}t_2\right)^{(k_2-.7)^2+.23}$$

Regular Instruction Effect $y(t)$
(no time allocated for CAI)
k_2 Curriculum Correlation

t Minutes	.70	.75	.80	.85	.90
5500	.72	.74	.78	.85	.97
6000	.77	.78	.83	.91	1.04
6500	.81	.83	.88	.97	1.10
7000	.86	.88	.93	1.02	1.17
7500	.91	.92	.98	1.08	1.24

$$y(t) = \left(\frac{175}{16000000}t + .0699\right)\left(\frac{69}{220}t\right)^{(k-.7)^2+.23}$$

Regular Instruction Mixed with CAI $y_1(t_1)+y_2(t_2)$
Compared with Regular Instruction $y(t)$
$k_1=.70$, $k_2=.90$, $k=.90$, $6000 \leq t_1+t_2 \leq 6900$

t_1	t_2	t_1/t	$y_1(t_1)$	$y_2(t_2)$	$y_1(t_1)+y_2(t_2)$	$y(t)$
1100	5200	.175	.22	.92	1.14	1.08
1100	5600	.164	.22	1.14	1.36	1.13
1200	4800	.200	.29	.71	1.00	1.04
1200	5200	.1875	.29	.92	1.21	1.09
1200	5600	.176	.29	1.14	1.43	1.14
1300	4800	.213	.36	.71	1.07	1.05
1300	5200	.200	.36	.92	1.28	1.10
1300	5600	.188	.36	1.14	1.50	1.16
1400	4800	.226	.43	.71	1.14	1.06
1400	5200	.212	.43	.92	1.35	1.11
1500	4800	.238	.50	.71	1.21	1.08
1500	5200	.224	.50	.92	1.42	1.13

for $6700 \leq t_1 + t_2 \leq 6900$ and $t_1/t = .188$

$y_1(t_1) + y_2(t_2) = 1.43$ and $\bar{y}(t) = 1.14$ are obtained

Time on Task

A task is a goal-oriented set of activities specifically intended to produce a particular learning outcome.[39]

The Carroll model for learning links time, student ability, achievement and the quality of instruction to define mastery learning.[14] Instruction, according to Bloom, depends on instructional cues, reinforcement, participation, feedback and correctives.[10] The timing of initial instruction, correctives, guided practice and student's progress to the next task are critical factors.

Effective teaching is enhanced as the proportion of time on task with allocated time increases.[21] Allocated time is the amount of time the school system or instructor sets aside for learning and time on task is that portion of the allocated time that students spend actually studying a subject or completing assigned learning activities. If a task is too difficult, time on task is wasted. If the student is on "target" and the task is at the appropriate level, then the probability that time on task will result in mastery of a skill or objective is increased.

Teachers are responsible for the classroom management that helps keep students on task and on target. Principals set policies which affect the time allocated for instruction. However, the amount of time on task desired to achieve a balance between academic and social learning and physical activities generally cannot be determined. Indivdual students are often observed to be gaining in self-esteem and motivation when that balance is achieved. Technology can help make time on task quality time and enhance the teacher's role as evaluator, counselor and manager of instructional activities.

DESCRIPTION OF IMPAC EXPERIMENTAL PROGRAMS

This investigation was an attempt to analyze data relative to applications of CAI or CMI-CAI and measure their effectiveness as supplementary instructional tools to traditional self-contained or departmentalized instructional programs. The effectiveness of CAI on the outcome criterion of student achievement, when CAI was used as a supplement, was evaluated using analysis of covariance and meta analysis techniques as well as the +, -, = gains technique usually employed through t-test or analysis of variance procedures. Non-parametric statistical techniques were used when assumptions related to parametric test could not be verified.

Four treatments of CAI were included in the study.

Treatment 1

Generally four microcomputers were located in a classroom with a self-contained organization in which the teacher worked with 2-3 reading and language arts or mathematics groups. Three types of CAI were used: comprehensive, single concept and game based. The objectives treated on the software relate to both SRA and Arkansas Basic Skills test. Students were placed on the computer relative to a ten day cycle and were scheduled on the computer 12-20 minutes each day ranging from 3 to 10 times during the 10 day cycle. A student used either a Commodore-64 or Apple IIe microcomputer.

Treatment 2

Generally eight microcomputers were networked to a self-contained or semi-departmentalized classroom in which the teacher worked with 2-3 mathematics groups. Two comprehensive mathematics software packages were used, one of which was game and tutorial based. The objectives treated relate to the SRA and Arkansas Basic Skills list. Students were scheduled on the computer relative to a 10 day cycle and were scheduled on the computer 12-20 minutes each day ranging from 4 to 10 times during the 10 day cycle. Each class used Apple IIe computers networked to a 20 megabyte Corvus hard disk. A printer was available in each classroom for management reports on student performance.

Treatment 3

Twenty-four microcomputers were located in a classroom and classes of students were brought to the "lab" using a schedule based on 30 minutes in which the students worked 15-25 minutes 8 days in 10. The software was identical to that used in Treatment 2. The lab used the same equipment described in Treatment 2.

Treatment 4

Eight Commodore Pet computers with 16 to 32 kilobytes of memory were networked using the Mupet network interfaced with a 4040 dual disk drive and a printer. A software package, C-AIM, developed by Dr. Tom Bishop, Arkansas State University, was used to monitor progress of students relative to Arkansas Mathematics Basic Skills. Students learned mathematics using traditional instructional methods and also used CAI on the Commodore 64. The CAI program was organized as defined in Treatment 1.

Assumptions related to statistical analysis had to be met to use the various parametric and nonparametric tests. Nonparametric tests usually impose fewer restrictions but may be less powerful.[40,69]

Analysis of variance and covariance procedures assume that three major conditions are satisfied. If either of the conditions are not satisfied the researcher usually selects an appropriate nonparametric test.

Assumption of Normality

It is assumed in using analysis of variance and covariance that the samples have been drawn from a normally distributed population.

Homogeneity of Variance

It is assumed in using the analysis of variance and covariance that the variances within the treatment and control groups are statistically equal. That is, the variances are assumed to be homogenous from group to group.

Continuity and Equal Intervals of Measure

The measures of attributes in the experimental and control groups must be continuous measures with equal intervals.

In the IMPAC research extreme care has been taken to detect when one or more of the assumptions, normality, homogeneity of variances, and equality of intervals was violated. In such instances, nonparametric test were used if feasible, otherwise the data was not used for evaluation purposes.

Analysis of covariance was used to adjust for initial differences in pretest achievement scores as measured by SRA tests. A computer program was developed by IMPAC which allowed for the analysis of data by grade, by subject, amount of time on task and performance by above and below grade level students. Also, students' attitudes toward the subject and the use of computers as a teaching device were studied.

In some cases analysis of variance and the t-test on difference between the mean statistical procedures were used. This was especially done when test related to pre-test group means and variances showed no significant differences at the .10 level and other mathematical assumptions were satisfied. In a few cases nonparametric techniques were used. This was especially the case when the power of a nonparametric test was greater than that available through the use of distribution related statistics.

The methodological technique of meta-analysis was employed for research integration purposes.[24] This procedure provides a comparison of discrete study findings using a common measure of treatment effectiveness. This measure is referred to as effect size or ES. Effect size is defined as the mean difference on the outcome variable between treated and untreated subjects divided by the within group standard deviation. The set of mean effect sizes relative to the same grade, subject and treatment were tested for statistical significance by means of the t-statistic deduced as the ratio of a given mean effect size to the standard error of the mean of the effect sizes under consideration. The null hypothesis stating that the mean effect size was zero was rejected only in instances in which the probability of committing Type I error was less than or equal to 0.10.

In general the ES data was arranged categorically according to small, medium and large effect size based on the values 0.2, 0.5 and 0.8. This partitioning of data has been used by other researchers and parallels the same type of decisions one makes in choosing α levels 0.1, 0.05 and 0.10. Therefore, a specific mean difference acquired from a particular comparison of two methods may be placed in one of two major categories: statistically significant for a given α level using a prescribed test, or statistically not significant for a given α level using a prescribed test. In either case the ES corresponding value was placed in one of four categories: negligible or negative effect, small effect, medium effect or large effect.

Due to the interest in cost effectiveness of educationally effective programs an analysis of the cost per student over a 5 year period was developed relative to each of the instructional program treatments. The cost reflects actual and projected cost associated with: software, hardware, in-service training, maintanence of software and hardware, insurance and teacher's aides.

This study also includes information on the match-up between the SRA and Arkansas Basic Skills objectives and the objectives covered by the software. Although the information presented is limited, IMPAC office files provide detailed information on this match-up. It suffices to provide assurance that numerous basic skills objectives were covered by the software which related directly to SRA and Arkansas Basic Skills.

Finally, an evaluation of hardware maintenance service, teacher evaluation of software and the effectiveness of CAI and IMPAC services is reported in detail and provides meaningful results in a number of areas.

QUALIFICATIONS OF TEACHERS IN THE EXPERIMENTAL AND CONTROL GROUPS

The following tables provide summary data on the qualifications of teachers in IMPAC experimental and control groups. Detailed information about each program and teacher qualifications by grade level are provided in the remainder of this section.

Composite Experimental

Grade	Bachelor Degrees	Master Degrees	Associate Degrees	Computer Experience None	Computer Experience Workshop	Computer Experience Courses	Avg. Teaching Experience
3	1	3	0	0	2	2	19.5
4	23	8	1	2	17	13	14.11
5	20	12	3	4	21	10	13.42
6	18	14	1	7	14	12	16.23
%	60%	35%	5%	12%	52%	36%	15.81

Composite Control

Grade	Bachelor Degrees	Master Degrees	Associate Degrees	Computer Experience None	Computer Experience Workshop	Computer Experience Courses	Avg. Teaching Experience
3	2	2	0	1	2	1	23.00
4	23	7	0	13	12	5	14.43
5	21	11	1	19	5	9	14.37
6	25	7	2	18	11	5	15.97
%	71%	27%	3%	50%	30%	20%	16.94

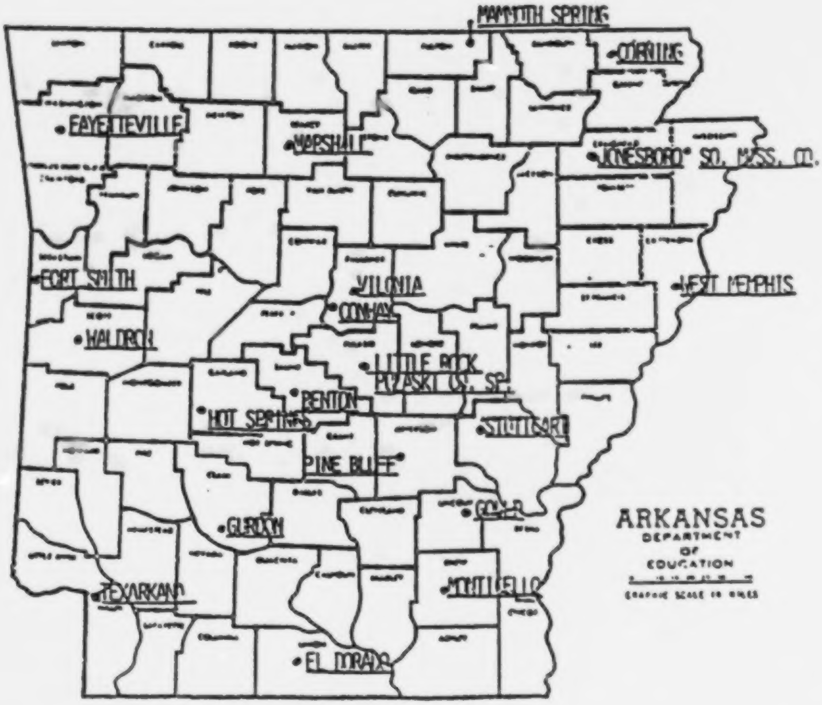
State
(Highest Earned Degree)
June 30, 1985

Certificate #	Certificate Type	Bachelor Degree	Master Degree	Other
183	Elem K-6	2027	790	5
184	Elementary	7528	3122	45
185	Graduate Elem	3	416	4
Total		9558	4328	54
Percent		68.6	31.0	.4

EVALUATION OF IMPAC IN-SERVICE WORKSHOPS BY PROGRAM TYPE

The in-service workshops conducted by IMPAC staff and hardware and software consultants were held at seven different sites and required two days of activities. Teachers were given release time and substitute teachers were paid by the school district. Two one-half day workshops were held each semester as additional software was added to the program.

The Commodore CAI workshop sites were Marshall (included Conway), Stuttgart (included Gould), Little Rock and Waldron. The Apple CAI workshop sites were El Dorado (included Texarkana and Gurdon) and Corning (included Mammoth Spring and So. Mississipi County). The CMI-CAI workshop was held in Little Rock at the Arkansas Department of Education for the project schools Fayetteville, Fort Smith, Monticello, Pulaski County (Maumelle), and Vilonia. The data on Pine Bluff teachers was not included since a separate workshop was held and the program was implemented later in the school year.


MAMMOTH SPRING
CORNING
FAYETTEVILLE
MARSHALL
JONESBORO
SO. MISS. CO.
FORT SMITH
VILONIA
CONWAY
WEST MEMPHIS
WALDRON
LITTLE ROCK
PULASKI CO. SP.
BENTON
HOT SPRINGS
STUTTGART
PINE BLUFF
GOULD
GURDON
TEXARKANA
MONTICELLO
EL DORADO
ARKANSAS
DEPARTMENT
OF
EDUCATION
GRAPHIC SCALE IN MILES

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Evaluation of IMPAC In-Service Workshops
for Commodore and Apple CAI Teachers
February - April, 1984

*Apple CAI El Dorado included Texarkana and Gurdon. Corning included Mammoth Spring and So. Mississippi County. Commodore CAI Marshall included Conway. Stuttgart included Gould.

Relevance of ideas	7	6	5	4	3	2	1
Marshall	8	1	0	0	0	0	0
Stuttgart	9	1	0	0	0	0	0
Little Rock	6	3	1	1	0	0	0
Waldron	8	2	2	2	0	0	0
El Dorado	16	3	1	0	0	0	0
Corning	14	3	0	2	0	0	0
Sub-total	61	13	4	5	0	0	0

Workshop organization	7	6	5	4	3	2	1
Marshall	6	3	0	0	0	0	0
Stuttgart	4	3	2	1	0	0	0
Little Rock	6	3	1	1	0	0	0
Waldron	2	6	3	1	2	0	0
El Dorado	20	0	0	0	0	0	0
Corning	12	4	2	0	1	0	0
Sub-total	50	19	8	3	3	0	0

Adequate time allotted	7	6	5	4	3	2	1
Marshall	0	1	2	4	1	1	0
Stuttgart	4	3	1	2	0	0	0
*Little Rock	0	2	2	2	3	1	0
Waldron	1	1	6	2	3	0	1
El Dorado	13	4	2	1	0	0	0
Corning	7	8	2	1	1	0	0
Sub-total	25	19	15	12	8	2	1

Interest generated through learning activites	7	6	5	4	3	2	1
Marshall	6	3	0	0	0	0	0
Stuttgart	10	0	0	0	0	0	0
Little Rock	8	1	1	1	0	0	0
Waldron	7	4	2	1	0	0	0
El Dorado	20	0	0	0	0	0	0
Corning	12	5	1	1	0	0	0
Sub-total	63	13	4	3	0	0	0

Perceived usefulness of IMPAC program	7	6	5	4	3	2	1
Marshall	9	0	0	0	0	0	0
Stuttgart	10	0	0	0	0	0	0
Little Rock	10	1	0	0	0	0	0
Waldron	10	2	1	1	0	0	0
El Dorado	17	1	2	0	0	0	0
Corning	15	4	0	0	0	0	0
Sub-total	71	8	3	1	0	0	0

Commitment to implementing program	7	6	5	4	3	2	1
Marshall	7	2	0	0	0	0	0
Stuttgart	9	1	0	0	0	0	0
Little Rock	9	1	1	0	0	0	0
Waldron	9	2	2	1	0	0	0
El Dorado	17	1	1	0	0	0	1
Corning	13	5	1	0	0	0	0
Sub-total	64	12	5	1	0	0	1

Extent to which workshop objectives were clarified	7	6	5	4	3	2	1
Marshall	7	2	0	0	0	0	0
Stuttgart	8	2	0	0	0	0	0
Little Rock	5	4	1	0	1	0	0
Waldron	7	3	2	2	0	0	0
El Dorado	15	4	1	0	0	0	0
Corning	14	4	1	0	0	0	0
Sub-total	56	19	5	2	1	0	0

Quality of presentation by IMPAC staff	7	6	5	4	3	2	1
Marshall	7	2	0	0	0	0	0
Stuttgart	6	4	0	0	0	0	0
Little Rock	8	1	2	0	0	0	0
Waldron	6	4	3	1	0	0	0
El Dorado	20	0	0	0	0	0	0
Corning	17	2	0	0	0	0	0
Sub-total	64	13	5	1	0	0	0

Preparation of IMPAC staff for workshop	7	6	5	4	3	2	1
Marshall	9	0	0	0	0	0	0
Stuttgart	6	4	0	0	0	0	0
Little Rock	10	1	0	0	0	0	0
Waldron	6	6	2	0	0	0	0
El Dorado	20	0	0	0	0	0	0
Corning	12	7	0	0	0	0	0
Sub-total	63	18	2	0	0	0	0

*One participant did not respond.

Totals for Commodore-CAI and Apple-CAI Participants

Items	7	6	5	4	3	2	1
1	61	13	4	5	0	0	0
2	50	19	8	3	3	0	0
3	25	19	15	12	8	2	1
4	63	13	4	3	0	0	0
5	71	8	3	1	0	0	0
6	64	12	5	1	0	0	1
7	56	19	5	2	1	0	0
8	64	13	5	1	0	0	0
9	63	18	2	0	0	0	0
TOTAL	517	134	51	28	12	2	2
%	69.3	18.0	6.9	3.8	1.6	0.2	0.2

Average: 6.48 or 92.6 on a scale of 100.

Evaluation of IMPAC In-Service
For Apple CMI-CAI Teachers
January, 1984

Workshop facilities	5	4	3	2	1
Monticello	1	3	1	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	7	0	0	0	0
Vilonia	1	5	0	0	0
Fort Smith	3	2	1	0	0
Sub-Total	14	12	2	0	0

Awareness activities	5	4	3	2	1
Monticello	4	1	0	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	5	2	0	0	0
Vilonia	4	2	0	0	0
Fort Smith	2	4	0	0	0
Sub-Total	17	11	0	0	0

Knowledge of CMI-CAI features	5	4	3	2	1
Monticello	5	0	0	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	5	2	0	0	0
Vilonia	4	2	0	0	0
Fort Smith	2	4	0	0	0
Sub-Total	18	10	0	0	0

Knowledge of management procedures	5	4	3	2	1
Monticello	4	1	0	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	5	2	0	0	0
Vilonia	3	1	2	0	0
Fort Smith	3	3	0	0	0
Sub-Total	17	9	2	0	0

Workshop organization	5	4	3	2	1
Monticello	4	1	0	0	0
Fayetteville	1	3	0	0	0
Pulaski County Special	6	1	0	0	0
Vilonia	4	2	0	0	0
Fort Smith	6	0	0	0	0
Sub-Total	21	7	0	0	0

Personal involvement in workshop activities	5	4	3	2	1
Monticello	5	0	0	0	0
Fayetteville	3	1	0	0	0
Pulaski County Special	7	0	0	0	0
Vilonia	6	0	0	0	0
Fort Smith	6	0	0	0	0
Sub-total	27	1	0	0	0

Motivation created by commitment	5	4	3	2	1
Monticello	4	1	0	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	6	1	0	0	0
Vilonia	5	1	0	0	0
Fort Smith	5	1	0	0	0
Sub-Total	22	6	0	0	0

Consultants' communication skills	5	4	3	2	1
Monticello	4	1	0	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	7	0	0	0	0
Vilonia	6	0	0	0	0
Fort Smith	3	3	0	0	0
Sub-Total	22	6	0	0	0

Perceived usefulness of IMPAC program	5	4	3	2	1
Monticello	3	2	0	0	0
Fayetteville	2	2	0	0	0
Pulaski County Special	5	2	0	0	0
Vilonia	5	1	0	0	0
Fort Smith	6	0	0	0	0
Sub-Total	21	7	0	0	0

Need more knowledge of IMPAC program expectations	5	4	3	2	1
Monticello	0	1	0	4	0
Fayetteville	0	1	1	1	0
Pulaski County Special	0	0	1	6	0
Vilonia	0	0	0	5	1
Fort Smith	0	0	1	4	1
Sub-Total	0	2	3	20	2

Need two additional days in-service	5	4	3	2	1
Monticello	1	0	2	0	0
Fayetteville	1	0	2	0	0
Pulaski County Special	3	2	0	2	0
Vilonia	0	2	1	1	2
Fort Smith	3	0	2	0	1
Sub-Total	8	4	7	3	3

Need help in making student assignments	5	4	3	2	1
Monticello	0	1	4	0	0
Fayetteville	1	1	1	0	0
Pulaski County Special	3	1	2	1	0
Vilonia	0	1	2	2	1
Fort Smith	0	3	2	0	0
Sub-Total	4	7	11	3	1

Need help in classroom management	5	4	3	2	1
Monticello	0	1	4	0	0
**Fayetteville	0	1	2	0	0
Pulaski County Special	1	0	3	2	1
Vilonia	0	2	1	2	1
*Fort Smith	0	3	2	0	0
Sub-Total	1	7	12	4	2

Need a courseware evaluation workshop	5	4	3	2	1
Monticello	0	1	3	1	0
**Fayetteville	1	1	0	0	1
Pulaski County Special	2	0	3	2	0
Vilonia	0	2	1	1	2
Fort Smith	1	2	3	0	0
Sub-Total	4	6	10	4	3

*One participant did not respond to the item.
**Two participants did not respond to the item.

Totals in CMI-CAI Participants

Items	5	4	3	2	1
1	14	12	2	0	0
2	17	11	0	0	0
3	18	10	0	0	0
4	17	9	2	0	0
5	21	7	0	0	0
6	27	1	0	0	0
7	22	6	0	0	0
8	22	6	0	0	0
9	21	7	0	0	0
Totals percent	179 71%	69 27%	4 2%	0 0	0 0

Items	5	4	3	2	1
10	0	2	3	20	2
11	8	4	7	3	3
12	4	7	11	3	1
13	1	7	12	4	2
14	4	6	10	4	3
Totals Percent	17 13%	26 20%	43 33%	34 26%	11 8%

Average 4.69 or 93.8 on a scale of 100 for the nine items related to the workshop.

STUDENT ATTITUDES TOWARD MATHEMATICS

Student attitudes toward mathematics were measured using the combination of an attitude survey and an attitude rating scale. The instrument was given to fifth and sixth grade students in experimental and control group classes.

The purpose of this part of the research was to develop an instrument that would assist IMPAC project teachers during 1985-87 in determining the initial status of classes with regard to attitude toward learning mathematics. Based on norms established during the 1983-85 research phase, classes that rated in the lower quartile would be identified so that teachers were aware that the usual motivational techniques might not be sufficient. Also, post-test placement of classes in a higher quartile could be determined by using class norms.

A x^2 test was conducted relative to the following hypothesis for grades 5 and 6 experimental group classes.

1. The frequency distributions of student responses in grades 5 by program type are equal

2. The frequency distributions of student responses in grade 6 by program type are equal

3. The frequency distributions of student responses by grade without regard to program type are equal

4. There is no dependent relationship between student responses, grade or program type

The validity of the attitude survey was determined by rank order correlations based on the actual rating of student attitudes by the teachers in experimental and control group classes. The correlations obtained ranged from 0.83 to 0.95. The overall correlation was 0.875. To be more specific, a typical teacher partitioned a class of 24 into three groups; top 25%, middle 50% and bottom 25%, according to the teacher's opinion of the students' interest and desire to do work in mathematics. The IMPAC attitude survey and attitude rating scales were then used to place the students in rank order. This validation procedure was based on nine classes ranging in size from 20-28 students.

The data in this section is reported either as the number and percentage of students responding positively to an item or just the percentage of students responding positively.

Scoring for the attitude survey and percentile ranks based on 1,408 student scores and 62 class averages will be used to refine the attitude survey during 1985-87.

Revised 1983

This attitude survey is to be given only to 5th and 6th grade experimental IMPAC mathematics classes (classes that use the computer on a regular basis).

IMPAC MATHEMATICS ATTITUDE SURVEY

Project School____________________ Grade Level ________ Date________

Experimental Mathematics classes only: Teacher ________________________

Your teacher will read each statement to you. Put an "X" in the box by the statement only if you generally agree with the statement. You will have ten seconds to think about each statement.

☐ (1) I like math because it is practical.

☐ (2) Math challenges me and keeps me busy.

☐ (3) Math has too many rules to learn.

☐ (4) I can't see much value in math.

☐ (5) I think math is the most enjoyable subject I have taken.

☐ (6) I don't feel sure of myself in math.

☐ (7) I have never liked math.

☐ (8) I think about math problems outside school and like to work them out.

☐ (9) I don't think math is fun, but I always want to do well in it.

☐ (10) I would like to spend more time in school working math.

☐ (11) I am not enthusiastic about math, but I have no real dislike for it either.

☐ (12) Math is very interesting.

(13) Please indicate your general feeling toward mathematics by circling exactly one number on a scale from 1 to 11. The number 11 will mean a strong like for mathematics, the number 1 will mean a strong dislike for mathematics, the number 6 will mean a neutral or ho-hum attitude toward mathematics.

1 2 3 4 5 6 7 8 9 10 11

☐ (14) Computers help me to learn more mathematics in school.

☐ (15) Computers are easy to use.

☐ (16) I enjoy using a computer.

Results - Hypothesis A

Grade 5 - Program Types: C-CAI, A-CAI and A-CMI-CAI
df=2 $X^2=4.61$ $\alpha=0.10$

There was a significant difference in the frequency distributions of items 3, 6 and 9.

		A-CMI-CAI			C-CAI			A-CAI		
Item	X^2	f	N	%	f	N	%	f	N	%
3	4.78	45	146	31	61	151	40	23	100	23
6	7.14	31	146	21	50	151	33	15	100	15
9	7.98	64	146	44	99	151	66	39	100	39

Grade 5 - Program Types: C-CAI and A-CAI
df=1 $X^2=2.71$ $\alpha=0.10$

There was no significant difference in the frequency distributions related to any of the items.

Grade 5 - Program Types: C-CAI and A-CMI-CAI
df=1 $X^2=2.71$ $\alpha=0.10$

There was no significant difference in the frequency distribution related to any of the items.

Grade 5 - Program Types: A-CAI and A-CMI-CAI
df=1 $X^2=2.71$ $\alpha=0.10$

There was a significant difference in the frequency distribution of items 6 and 9.

		A-CAI			A-CMI-CAI		
Item	X^2	f	N	%	f	N	%
6	3.54	50	151	33.1	15	100	15.0
9	3.38	99	151	65.6	39	100	39.0

Results - Hypothesis B

Grade	Program Type	df	X^2 for α =.10	Result
6	C-CAI/A-CAI/A-CMI-CAI	2	4.61	NS
6	C-CAI/A-CAI	1	2.71	NS
6	C-CAI/A-CMI-CAI	1	2.71	NS
6	A-CAI/A-CMI-CAI	1	2.71	NS

Results - Hypothesis C

Grade	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16
5	65	75	32	9	48	24	15	48	56	25	61	61	89	93	91
6	71	80	29	7	36	30	22	45	66	29	59	52	93	88	91

5th and 6th grade
df = 14 x^2 = 21.1 α = 0.10
X^2 obtained was 6.97

There was no significant difference in the frequency distributions of the response of 5th and 6th grade students independent of program type.

Results - Hypothesis D

Grade 5 - Program Types: C-CAI, A-CAI and A-CMI-CAI and each item

	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16
C-CAI	58	77	31	10	43	21	15	43	44	35	61	58	77	90	95
A-CAI	70	71	40	9	55	33	16	54	66	33	62	57	78	87	93
A-CMI-CAI	71	79	23	7	54	15	15	49	39	37	54	72	88	93	99

df=28 X^2 =37.9 α =0.10
X^2 obtained was 27.42

There was no significant difference in the frequency distributions related to any of the items.

Grade 6 - Program Types: C-CAI, A-CAI and A-CMI-CAI and each item

	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16
C-CAI	82	80	28	4	37	31	14	55	65	34	53	59	87	92	96
A-CAI	65	82	28	9	39	28	25	45	62	31	59	52	79	89	91
A-CMI-CAI	71	78	28	8	30	28	20	39	63	24	49	47	79	94	94

df=28 X^2 =37.9 α =0.10
X^2 obtained was 13.57

There was no significant difference in the frequency distribution related to any of the items.

Summary of Results

The greatest difference in frequency distributions occurred in cells that related to item 9: "I don't think math is fun, but I always want to do well in it." The next greatest difference in frequency distribution occurred in cells that related to item 3: "Math has too many rules to learn" and Item 6: "I don't feel sure of myself in math."

It is reasonable to assume that student attitudes toward mathematics should not be a factor in differences in achievement scores between program type or between grades in the experimental group.

Summary of IMPAC Mathematics Attitude Survey By Grade and Program Type

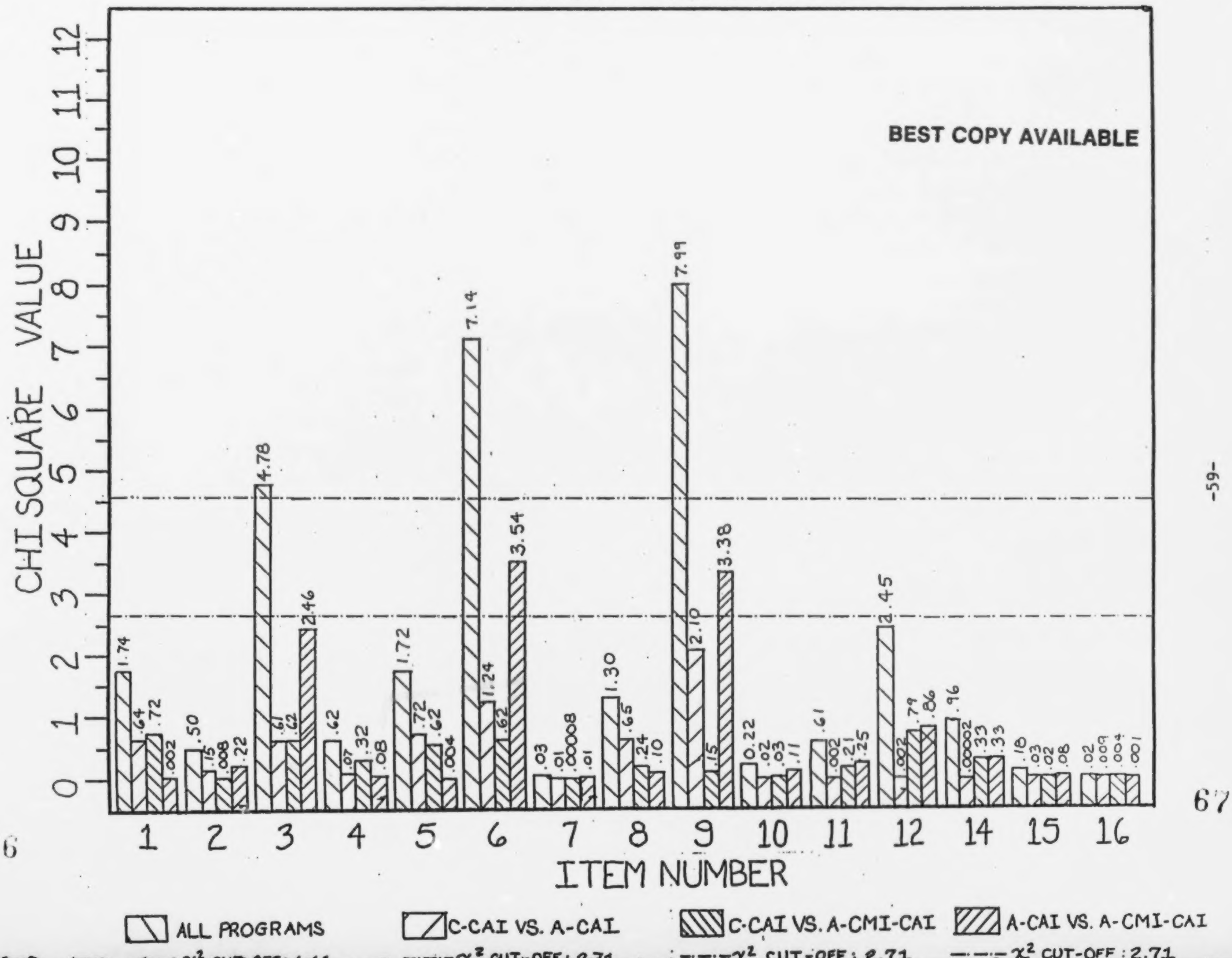
Experimental Group
Grade 5

	Commodore CAI		Apple CAI		Apple CMI-CAI		Totals	
n =	146		151		100			
Question	f	%	f	%	f	%	f	%
1	84	57.5%	106	70.2%	71	71.0%	261	65.7%
2	113	77.4%	107	70.9%	79	79.0%	299	75.3%
3	45	30.8%	61	40.4%	23	23.0%	129	32.5%
4	15	10.3%	13	8.6%	7	7.0%	35	8.8%
5	63	43.2%	83	55.0%	54	54.0%	200	50.4%
6	31	21.2%	50	33.1%	15	15.0%	96	24.2%
7	22	15.1%	24	15.9%	15	15.0%	61	15.4%
8	62	42.5%	81	53.6%	49	49.0%	192	48.4%
9	64	43.8%	99	65.6%	39	39.0%	202	50.9%
10	51	34.9%	50	33.1%	37	37.0%	138	34.8%
11	89	61.0%	93	61.6%	54	54.0%	236	59.4%
12	84	57.5%	86	57.0%	72	72.0%	242	61.0%
13	avg:	7.6	avg:	7.7	avg:	8.2	avg:	7.8
14	113	77.4%	117	77.5%	88	88.0%	318	80.1%
15	132	90.4%	132	87.4%	93	93.0%	357	89.9%
16	139	95.2%	141	93.4%	94	94.0%	374	94.2%

Summary of IMPAC Mathematics Attitude Survey By Grade and Program Type
Experimental Group
Grade 6

n =	115		170		109			
	Commodore CAI		Apple CAI		Apple CMI-CAI		Totals	
Question	f	%	f	%	f	%	f	%
1	94	81.7%	110	64.7%	77	70.6%	281	71.3%
2	92	80.0%	139	81.8%	85	78.0%	316	80.2%
3	32	27.8%	48	28.2%	31	28.4%	111	28.2%
4	5	4.3%	15	8.8%	9	8.3%	29	7.4%
5	43	37.4%	67	39.4%	33	30.3%	143	36.3%
6	36	31.3%	47	27.6%	31	28.4%	114	28.9%
7	16	13.9%	42	24.7%	22	20.2%	80	20.3%
8	63	54.8%	76	44.7%	42	38.5%	181	45.9%
9	75	65.2%	105	61.8%	69	63.3%	249	63.2%
10	39	33.9%	52	30.6%	26	23.9%	117	29.7%
11	61	53.0%	101	59.4%	53	48.6%	215	54.6%
12	68	59.1%	89	52.4%	51	46.8%	208	52.8%
13	avg:	7.4	avg:	7.2	avg:	7.3	avg:	7.8
14	100	87.0%	135	79.4%	86	78.9%	321	81.5%
15	106	92.2%	152	89.4%	102	93.6%	360	91.4%
16	110	95.7%	155	91.2%	102	93.6%	367	93.1%

5TH GRADE EXPERIMENTAL



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6 GRADE EXPERIMENTAL

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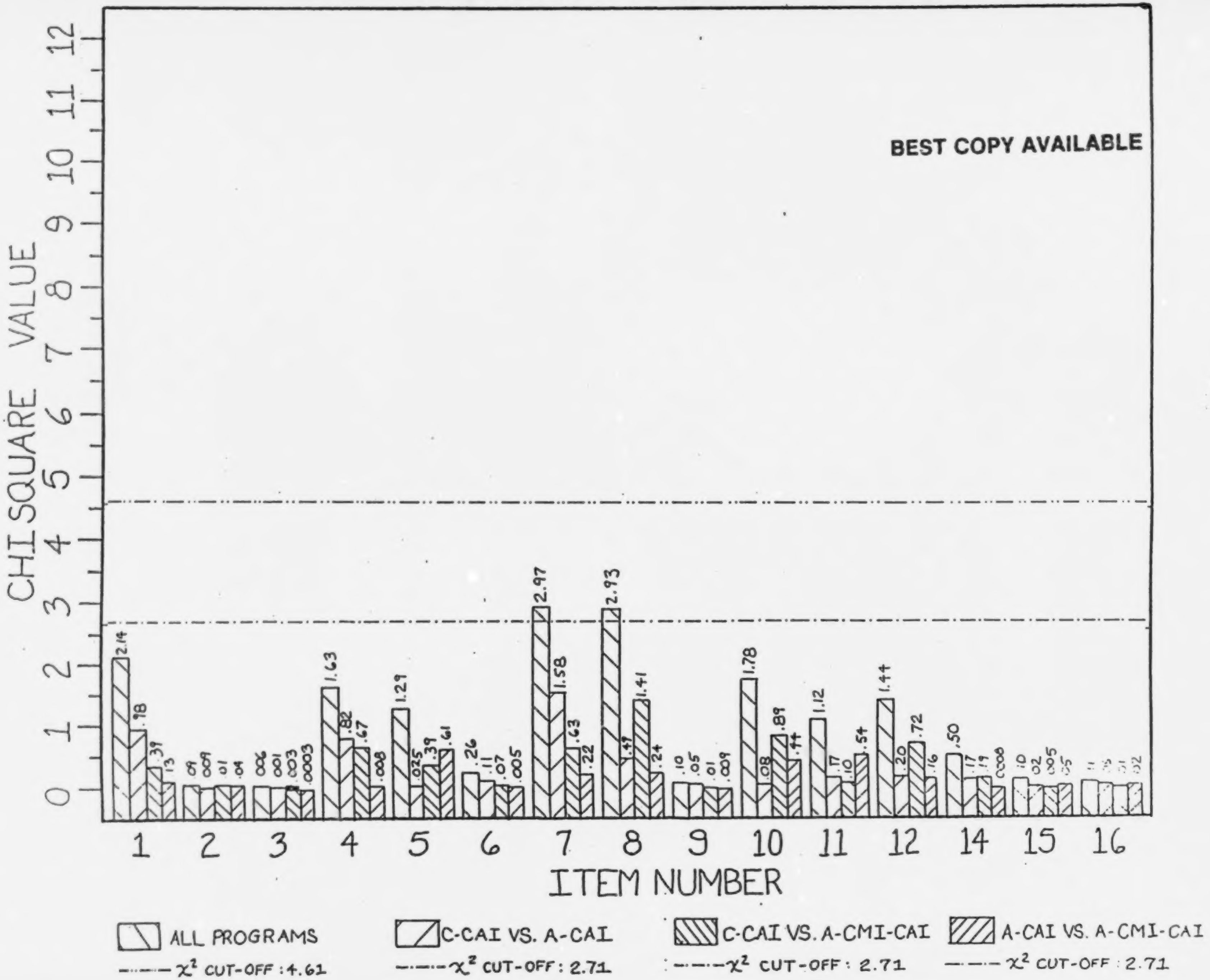


Student Attitudes Toward Mathematics

Grade 5-6 Control Group

X^2 values were computed relative to the following hypothesis:

1. The frequency distributions of student responses in grade 5 by program type are equal

2. The frequency distributions of student responses in grade 6 by program type are equal

3. The frequency distribution of student responses by grade without regard to program type are equal

4. There is no dependence relationship between student responses, grade or program type

The validity of the attitude survey was determined by the rank order correlations based on actual ratings of student attitudes by the teacher in experimental and control group classes. The correlations ranged from 0.83 to 0.95. The overall correlation was 0.875.

Revised 1985

This attitude survey is to be given only to 5th and 6th grade control group mathematics classes

IMPAC MATHEMATICS ATTITUDE SURVEY

Project School____________________________ Grade Level ___________ Date___________

Control Group Mathematics classes only: Teacher __________________________________

Your teacher will read each statement to you. Put an "X" in the box by the statement only if you generally agree with the statement. You will have ten seconds to think about each statement.

☐ (1) I like math because it is practical.

☐ (2) Math challenges me and keeps me busy.

☐ (3) Math has too many rules to learn.

☐ (4) I can't see much value in math.

☐ (5) I think math is the most enjoyable subject I have taken.

☐ (6) I don't feel sure of myself in math.

☐ (7) I have never liked math.

☐ (8) I think about math problems outside school and like to work them out.

☐ (9) I don't think math is fun, but I always want to do well in it.

☐ (10) I would like to spend more time in school working math.

☐ (11) I am not enthusiastic about math, but I have no real dislike for it either.

☐ (12) Math is very interesting.

☐ (13) Please indicate your general feeling toward mathematics by circling exactly one number on a scale from 1 to 11. The number 11 will mean a strong like for mathematics, the number 1 will mean a strong dislike for mathematics, the number 6 will mean a neutral or ho-hum attitude toward mathematics.

1 2 3 4 5 6 7 8 9 10 11

70

Results - Hypothesis A

Grade 5 - Program Types: C-CAI, A-CAI and A-CMI-CAI

There was a significant difference in the frequency distribution of items 8 and 9.

df=2 X^2 =4.61 α =0.10

		C-CAI			A-CAI			A-CMI-CAI		
Item	X^2	f	N	%	f	N	%	f	N	%
8	6.28	57	75	76.0	65	129	50.4	54	95	56.8
9	5.81	63	75	84.0	73	189	56.6	67	95	70.5

Grade 5 - Program Type: C-CAI and A-CAI

df=1 X^2 =2.71 α =0.10

There were no significant differences in the frequency distribution for any of the items.

Grade 5 - Program Type: C-CAI and A-CMI-CAI

df=1 X^2 =2.71 α =0.10

There were no significant differences in the frequency distribution for any of the items.

Grade 5 Program Type: A-CAI and A-CMI-CAI

df=1 X^2 =2.71 α =0.10

There were no significant differences in the frequency distributions for any of the items.

Results - Hypothesis B

Grade 6 - Program Type: C-CAI, A-CAI, A-CMI-CAI
df=2 X^2 =4.61 α =0.10

There was a significant difference in the frequency distributions related to items 1, 4, 5 and 8.

		C-CAI			A-CAI			A-CMI-CAI		
Item	X^2	f	N	%	f	N	%	f	N	%
1	17.85	31	76	40.8	97	119	81.5	43	97	44.3
4	10.50	2	76	2.6	13	119	10.9	1	97	1.0
5	11.81	35	76	46.1	56	119	47.1	20	97	20.6
8	7.31	25	76	32.9	67	119	56.3	36	97	37.1

Grade 6 - Program Types: C-CAI and A-CAI
df=1 X^2 =2.71 α =0.10

There was a significant difference in the frequency distribution related to items 1 and 8

		C-CAI			A-CAI		
Item	X^2	f	N	%	f	N	%
1	6.83	31	76	40.8	97	119	81.5
8	3.10	25	76	32.9	67	119	56.3

Grade 6 - Program Type: C-CAI and A-CMI-CAI
df=2 X^2 =4.61 α =0.10

There was a significant difference in the frequency distribution related to item 5.

		C-CAI			A-CMI-CAI		
Item	X^2	f	N	%	f	N	%
5	5.34	35	76	46.1	20	97	20.6

Grade 6 - Program Types: A-CAI and A-CMI-CAI
df=2 X^2 =4.61 α =0.10

There was a significant difference in the frequency distribution related to items 1, 4 and 5.

		A-CAI			A-CMI-CAI		
Item	X^2	f	N	%	f	N	%
1	5.42	97	119	81.5	43	97	44.3
4	4.81	13	119	10.9	1	97	1.0
5	5.66	56	119	47.1	20	97	20.6

Results - Hypothesis C

Grade	1	2	3	4	5	6	7	8	9	10	11	12
5	73.9	80.3	30.4	11.0	49.5	26.1	14.0	58.9	67.9	36.5	66.6	68.2
6	58.6	76.0	27.7	5.5	38.0	27.1	18.5	43.8	62.3	24.3	56.5	57.4

df=1 X^2 =17.275 α =0.10
X^2 obtained was 5.59

There was no significant differences in the frequency distribution of the responses of the 5th and 6th grade students independent of program type.

Results - Hypothesis D

Grade 5 - Program Types: C-CAI, A-CAI and A-CMI-CAI and each item

	1	2	3	4	5	6	7	8	9	10	11	12
C-CAI	68.0	77.3	36.0	10.7	57.3	28.0	20.0	76.0	84.0	34.7	77.3	72.0
A-CAI	72.9	78.3	31.8	10.9	52.7	22.5	11.6	50.4	56.6	41.1	61.2	68.2
A-CMI-CAI	80.0	85.3	24.2	11.6	38.9	29.5	12.6	56.8	70.5	31.6	65.3	65.3

df=22 X^2 =30.81 α =0.10
X^2 obtained was 19.40

There was no significant differences in the frequency distributions related to any of the items.

Grade 6 - Program Types: C-CAI, A-CAI and A-CMI-CAI and each item

	1	2	3	4	5	6	7	8	9	10	11	12
C-CAI	40.8	69.7	26.3	2.6	46.1	27.6	17.1	32.9	59.2	27.6	55.3	56.6
A-CAI	81.5	74.8	31.1	10.0	47.1	28.6	17.6	56.3	58.8	28.6	58	65.5
A-CMI-CAI	44.3	82.5	24.7	1.0	70.6	24.7	20.6	37.1	69.1	16.5	55.7	49.5

df=22 X^2 =30.81 α =0.10
X^2 obtained was 43.37

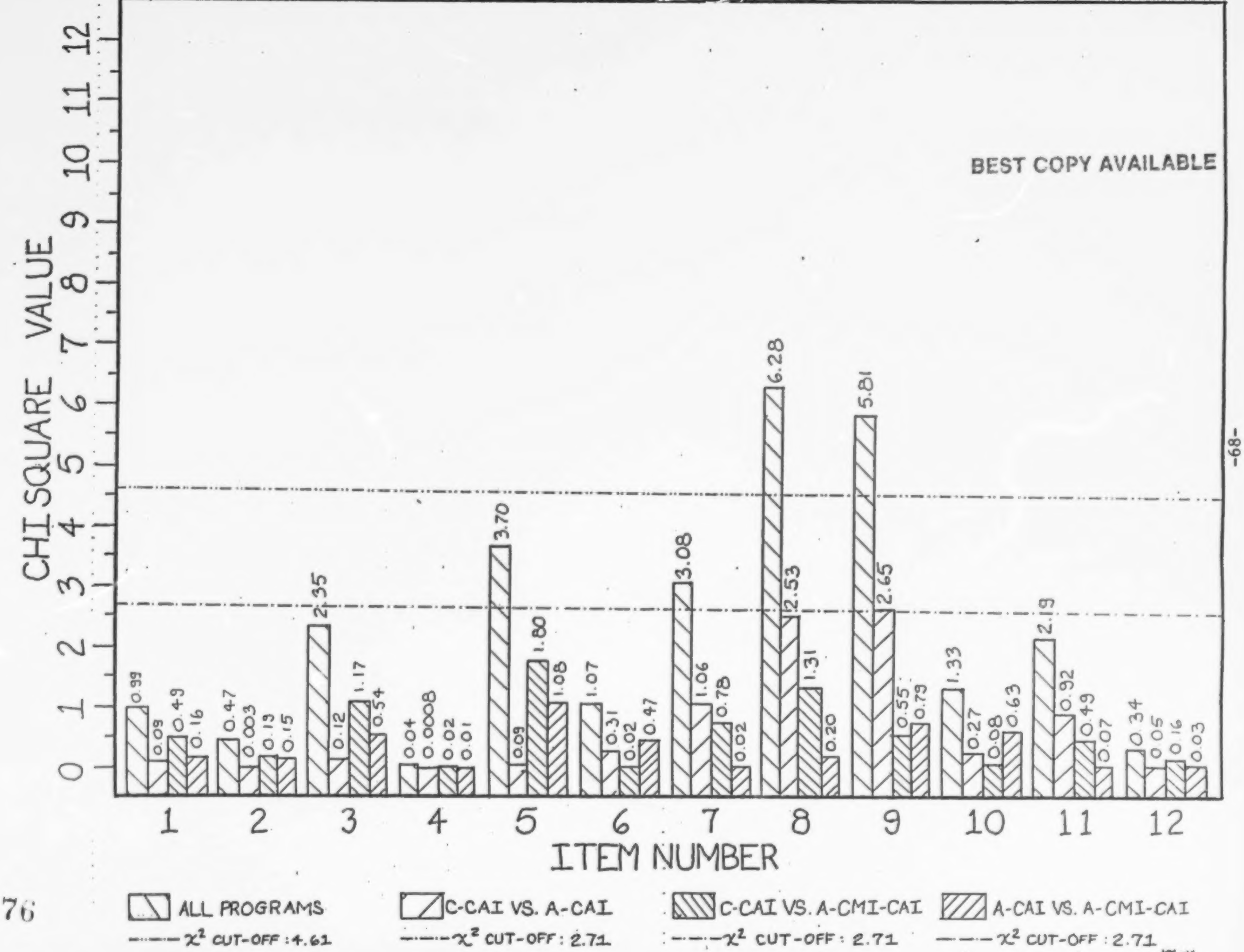
The X^2 value obtained was significant at the α =0.10 level. Therefore, H was rejected. There were differences in the responses to some of the items by program types. The items contributing the most to the value of 43.37: Item 1, A-CAI and Item 5, A-CMI-CAI.

Summary of IMPAC Mathematics Attitude Survey By Grade and Program Type
Control Group
Grade 5

n =	75		129		95			
	Commodore CAI		Apple CAI		Apple CMI-CAI		Totals	
Question	f	%	f	%	f	%	f	%
1	51	68.0%	94	72.9%	76	80.0%	221	73.9%
2	58	77.3%	101	78.3%	81	85.3%	240	80.3%
3	27	36.0%	41	31.8%	23	24.2%	91	30.4%
4	8	10.7%	14	10.9%	11	11.6%	33	11.0%
5	43	57.3%	68	52.7%	37	38.9%	148	49.5%
6	21	28.0%	29	22.5%	28	29.5%	78	26.1%
7	15	20.0%	15	11.6%	12	12.6%	42	14.0%
8	57	76.0%	65	50.4%	54	56.8%	176	58.9%
9	63	84.0%	73	56.6%	67	70.5%	203	67.9%
10	26	34.7%	53	41.1%	30	31.6%	109	36.5%
11	58	77.3%	79	61.2%	62	65.3%	199	66.6%
12	54	72.0%	88	68.2%	62	65.3%	204	68.2%
13	avg:	8.5	avg:	8.0	avg:	8.4	avg:	8.2

Summary of IMPAC Mathematics Attitude Survey By Grade and Program Type
Control Group
Grade 6

n =	76		119		97			
	Commodore CAI		Apple CAI		Apple CMI-CAI		Totals	
Question	f	%	f	%	f	%	f	%
1	31	40.8%	97	81.5%	43	44.3%	171	58.6%
2	53	69.7%	89	74.8%	80	82.5%	222	76.0%
3	20	26.3%	37	31.1%	24	24.7%	81	27.7%
4	2	2.6%	13	10.9%	1	1.0%	16	5.5%
5	35	46.1%	56	47.1%	20	20.6%	111	38.0%
6	21	27.6%	34	28.6%	24	24.7%	79	27.1%
7	13	17.1%	21	17.6%	20	20.6%	54	18.5%
8	25	32.9%	67	56.3%	36	37.1%	128	43.8%
9	45	59.2%	70	58.8%	67	69.1%	182	62.3%
10	21	27.6%	34	28.6%	16	16.5%	71	24.3%
11	42	55.3%	69	58.0%	54	55.7%	165	56.5%
12	43	56.6%	78	65.5%	48	49.5%	169	57.9%
13	avg:	7.5	avg:	8.3	avg:	6.9	avg:	7.7



5TH GRADE CONTROL

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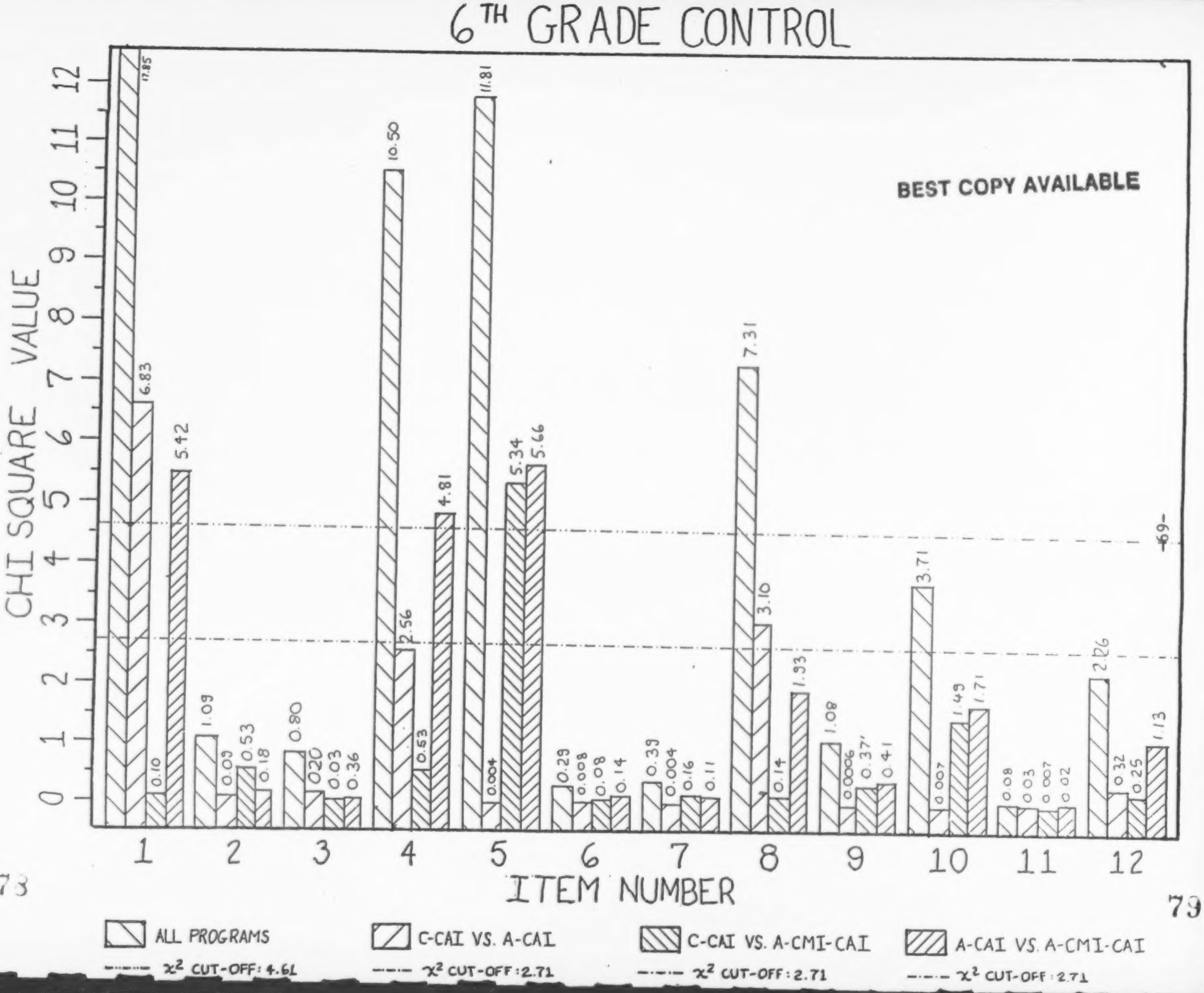

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EVALUATIONS OF IMPAC PROGRAMS BY PROJECT TEACHERS

A Likert scale was developed related to the effectiveness, moderate effectiveness or ineffectiveness of various aspects of the IMPAC programs. The scale, 0-6, was used with fourteen questions related to mathematics software, reading and language arts software, program effectiveness in the classroom and technical support from vendors, IMPAC staff and local coordinators.

Scale Definition

Teachers completing the evaluation form were asked to select a number 0-6 according to the following instructions:

6 -- Effective - not perfect but no improvement is needed

5 -- Effective - program can be improved at either the classroom, building, or district level without help from IMPAC

4 -- Effective - program can be improved with help from IMPAC

3 -- Moderately effective -- Improvement cannot be justified in light of other needs

2 -- Ineffective - Improvement can be made at either the classroom, building or district level without help from IMPAC

1 -- Ineffective - Improvement can be made only with help from IMPAC

0 -- Ineffective - No improvement can be made

The 0-6 scale not only served as a rating system but also provided directions for program improvement.

C-CAI means Commodore CAI program
A-CAI means Apple CAI program
A-CMI-CAI means Apple CMI-CAI program in mathematics only

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EVALUATION OF IMPAC BY PROJECT TEACHERS

IMPAC Project School/District____

Teacher______________________________ Grade Level_________________

Classroom Organization (Please Check One):
Self-contained________ Departmentalized________ Semi-Departmentalized________

Number of days during a ten day period a student has lessons on a computer. (Example: 5/10 means 5 days in 10):
Language Arts and Reading__________ Math__________

Number of minutes of regular scheduled time (do not include computer time):
Language Arts and Reading__________ Math__________

Please read and rank each item according to the following scale:

6 -- Effective - not perfect but no improvement is needed

5 -- Effective - program can be improved at either the classroom, building, or district level without help from IMPAC

4 -- Effective - Program can be improved with help from IMPAC

3 -- Moderately Effective - Improvement cannot be justified in light of other needs

2 -- Ineffective - Improvement can be made at either the classroom, building, or district level without help from IMPAC

1 -- Ineffective - Improvement can be made only with help from IMPAC

0 -- Ineffective - No improvement can be made

_____ 1. Effectiveness of the number of computers for student use

_____ 2. Effectiveness of your microcomputers in presenting the CAI lessons

_____ 3. Effectiveness of the computer company in keeping your computers, monitors, and disk drives working

_____ 4. Effectiveness of the amount of math software

_____ 5. Effectiveness of the math software in basic skills instruction

_____ 6. Your effectiveness in using CAI as a supplement to your basic mathematics instructional program

_____ 7. Effectiveness of the IMPAC program in your classroom in helping you improve basic instruction in math

_____ 8. Effectiveness of the amount of reading and language arts software

_____ 9. Effectiveness of the reading and language arts software in basic skills instruction

_____ 10. Your effectiveness in using CAI as a supplement to your basic reading and language arts instructional program

_____ 11. Effectiveness of the IMPAC program in your classroom in helping you improve basic instruction in reading and language arts

_____ 12. Effectiveness of the assistance provided to you by other teachers or supervisors at the local level

_____ 13. Effectiveness of the software company in keeping your software working

_____ 14. Effectiveness of the assistance provided to you by IMPAC in solving problems relating to service or equipment, need for more software, need for software storage, and in-service training

Comparison of Teacher Evaluation of IMPAC Program by Program Type

ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	AVE
C-CAI	5.42	4.79	4.00	5.09	5.41	5.23	5.27	4.05	4.64	4.91	4.73	5.21	4.42	5.54	4.91
A CAI	4.89	5.53	5.50	5.52	5.81	5.55	5.39	4.47	4.63	4.50	4.53	5.57	5.36	5.49	5.12
A-CMI-CAI	5.90	4.79	5.39	5.15	5.05	5.05	5.33	X	X	X	X	5.33	4.78	4.95	5.19

A-CMI-CAI teachers did not respond to Items 8, 9, 10 and 11.

It should be noted, as measured by item 3, that the rating of the quality of maintenance related to the Commodore 64 program was significantly lower than the rating of the quality of the maintenance related to the Apple IIe. After six months, the company repairing Commodore 64 equipment revised its maintenance program and their service was very satisfactory.

Responses to Items 4, 5, 6 and 7 indicate that the Apple CAI math program had a higher rating than the other two programs. However, the Commodore CAI and Apple CAI program were rated about equal when the responses to Items 8, 9, 10, and 11 are also considered.

Support from local supervisors and IMPAC staff was good based on responses to Items 12 and 14. However, software vendor support as measured by Item 13 was rated low for Commodore CAI and Apple CMI-CAI. Errors in the software presented serious problems in using the Diascriptive Reading Program in the Commodore CAI program and the San Deigo Supplementary Mathematics program in the Apple CM-CAI program.

Responses to Items 4 and 9 indicate that the teachers felt better about the amount of math software compared to the amount of reading and language arts software being used in the programs. The teachers likewise felt better about the supplementary use of mathematics software compared to the supplementary use of reading and language arts software as measured by Items 6 and 10.

Responses to items using 3 and 6 give a measure of the components of the program that need no problem resolution. Responses to items using 2 and 5 relate to problems that can be resolved at the local level, whereas response to items using 1 and 4 relate to problems that are viewed as resolvable only by IMPAC assistance.

Problem Resolution

	No Problem Resolution Required	Problems Resolved at Local Level	Problems Resolved by IMPAC
C-CAI	45.9%	25.9%	28.2%
A-CAI	60.3%	14.8%	24.9%
A-CMI-CAI	55.8%	21.3%	22.9%
All 3 programs	53.4%	20.3%	26.3%

Comparison Results on Specific Items

ITEM 3 -- Hardware Service

Grade Level	4	5	6	Avg.
C-CAI	3.90	3.67	3.75	3.77
A-CAI	5.42	5.25	5.83	5.50
A-CMI-CAI	5.50	5.17	5.50	5.39

ITEM 13 -- Software Service

Grade Level	4	5	6	Avg.
C-CAI	3.88	5.00	4.89	4.62
A-CAI	4.75	5.50	5.83	5.08
A-CMI-CAI	5.25	5.00	4.25	4.72

ITEM 1 -- Number of Machines (rating affected by self contained / departmental organization)

Grade Level	4	5	6	Avg.
C-CAI	5.60	4.67	5.33	5.21
A-CAI	5.17	4.91	4.83	4.97
A-CMI-CAI	6.00	6.00	5.75	5.90

ITEM 7 -- Effectiveness of IMPAC Program in Mathematics

Grade level	4	5	6	Avg.
C-CAI	5.22	5.00	5.29	5.17
A-CAI	5.67	5.44	5.00	5.39
A-CMI-CAI	5.67	4.86	5.63	5.33

ITEM 11 -- Effectiveness of IMPAC Program in Reading and Langauge Arts

Grade Level	4	5	6	Avg.
C-CAI	4.33	5.14	4.63	4.67
A-CAI	4.25	4.36	4.70	4.42
A-CMI-CAI	NA	NA	NA	NA

Teacher Evaluation
Overall Averages on all Items

Program	Grades	Average
C-CAI	4-5-6	4.84
A-CAI	4-5-6	5.22
A-CMI-CAI	4-5-6	5.17
All Three Programs	4-5-6	5.07
C-CAI	4	4.90
C-CAI	5	4.82
C-CAI	6	5.00
A-CAI	4	5.25
A-CAI	5	5.05
A-CAI	6	5.27
A-CMI-CAI	4	5.15
A-CMI-CAI	5	5.10
A-CMI-CAI	6	5.24
All Three Program	4	5.07
All Three Programs	5	4.98
All Three Programs	6	5.14

X^2 Test Related to Frequency Distribution By Program and Grade Level

Grade	Comparison (* significant)	X^2 (* significant)	df	.10 level
4	A-CAI*/C-CAI	10.37*	5	9.236
4	A-CAI*/A-CMI-CAI	9.85*	5	9.236
4	C-CAI/A-CMI-CAI	6.24	5	9.236
5	A-CAI/C-CAI	6.71	5	9.236
5	A-CAI/A-CMI-CAI	3.09	5	9.236
5	C-CAI/A-CMI-CAI*	11.45*	5	9.236
6	A-CAI*/C-CAI	19.90*	5	9.236
6	A-CAI*/A-CMI-CAI	12.04*	5	9.236
6	C-CAI/A-CMI-CAI	6.06	5	9.236

Program	Comparison	X^2	df	.10 level
A-CMI-CAI	Grades 4* & 5	11.13	5	9.236
A-CMI-CAI	Grades 5 & 6*	10.83	5	9.236
A-CMI-CAI	Grades 4 & 6	1.21	5	9.236
C-CAI	Grades 4 & 5	5.88	5	9.236
C-CAI	Grades 5 & 6	2.72	5	9.236
C-CAI	Grades 4 & 6	9.09	5	9.236
A-CAI	Grades 4* & 5	9.83	5	9.236
A-CAI	Grades 5 & 6*	9.26	5	9.236
A-CAI	Grades 4 & 6	1.79	5	9.236

Summary

	Grade			
	4	5	6	Overall
C-CAI	4.82	4.90	5.00	4.84
A-CAI	5.25	5.05	5.27	5.22
A-CMI-CAI	5.15	5.10	5.24	5.17
Overall	5.09	4.96	5.17	5.07

Teachers in grade 6 independent of program type rated the program highest 5.17. The teacher rating of the A-CAI program was the highest 5.22. The teachers in grade 6 in the Apple-CAI program rated the program highest 5.27. However, the evaluations in all categories are very similiar and it would not be appropriate to rank order any of this data. It is clear that the Commodore-CAI evaluations were affected by two factors, vendor support related to repairs and defective software.

Teacher Evaluation of IMPAC Programs
by Grade and Program Type
Grade 4

			frequency					
Item	6	5	4	3	2	1	0	Average
1 C-CAI	8	0	2	0	0	0	0	5.60
A-CAI	6	2	4	0	0	0	0	5.17
A-CMI/CAI	4	0	0	0	0	0	0	6.00
Total	18	2	6	0	0	0	0	5.46
2 C-CAI	2	1	5	2	0	0	0	4.30
A-CAI	12	0	0	0	0	0	0	6.00
A-CMI/CAI	1	1	1	0	0	1	0	4.00
Total	15	2	6	2	0	1	0	5.04
3 C-CAI	1	2	4	2	0	1	0	3.90
A-CAI	8	1	3	0	0	0	0	5.42
A-CMI/CAI	3	0	1	0	0	0	0	5.50
Total	12	3	8	2	0	1	0	4.85
4 C-CAI	7	0	2	0	0	0	0	5.56
A-CAI	11	1	0	0	0	0	0	5.92
A-CMI/CAI	3	0	1	0	0	0	0	5.50
Total	21	1	3	0	0	0	0	5.72
5 C-CAI	6	1	2	0	0	0	0	5.44
A-CAI	11	1	0	0	0	0	0	5.92
A-CMI/CAI	2	1	0	0	0	1	0	4.50
Total	19	3	2	0	0	1	0	5.52
6 C-CAI	4	5	0	0	0	0	0	5.44
A-CAI	10	2	0	0	0	0	0	5.83
A-CMI/CAI	0	3	1	0	0	0	0	4.75
Total	14	10	1	0	0	0	0	5.52
7 C-CAI	4	3	2	0	0	0	0	5.22
A-CAI	10	0	2	0	0	0	0	5.67
A-CMI/CAI	2	1	0	0	0	0	0	5.67
Total	16	4	4	0	0	0	0	5.50

Item		frequency							
		6	5	4	3	2	1	0	Average
8	C-CAI	1	1	5	0	0	2	0	3.67
	A-CAI	5	2	4	0	0	1	0	4.75
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	6	3	9	0	0	3	0	4.29
9	C-CAI	3	2	2	0	0	2	0	4.22
	A-CAI	3	2	6	0	0	1	0	4.42
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	6	4	8	0	0	3	0	4.33
10	C-CAI	5	1	1	0	2	0	0	4.78
	A-CAI	2	3	5	1	1	0	0	4.33
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	7	4	6	1	3	0	0	4.52
11	C-CAI	4	0	2	1	2	0	0	4.33
	A-CAI	3	2	4	2	0	1	0	4.25
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	7	2	6	3	2	1	0	4.29
12	C-CAI	5	4	1	0	0	0	0	5.40
	A-CAI	8	2	1	1	0	0	0	5.42
	A-CMI/CAI	1	3	0	0	0	0	0	5.25
	Total	14	9	2	1	0	0	0	5.38
13	C-CAI	2	1	3	0	0	2	0	3.88
	A-CAI	4	1	7	0	0	0	0	4.75
	A-CMI/CAI	2	1	1	0	0	0	0	5.25
	Total	8	3	11	0	0	2	0	4.54
14	C-CAI	7	1	2	0	0	0	0	5.50
	A-CAI	11	0	1	0	0	0	0	5.83
	A-CMI/CAI	2	1	1	0	0	0	0	5.25
	Total	20	2	4	0	0	0	0	5.62

Overall	C-CAI	59	22	33	5	4	7	0	4.82
	%	45.38%	16.92%	25.38%	3.85%	3.08%	5.38%	0.00%	
	A-CAI	104	19	39	4	1	3	0	5.25
	%	61.18%	11.18%	22.94%	2.35%	0.59%	1.76%	0.00%	
	A-CMI/CAI	20	11	6	0	0	2	0	5.15
	%	51.28%	28.21%	15.38%	0.00%	0.00%	5.13%	0.00%	
	Total	183	52	78	9	5	12	0	5.07
	%	53.98%	15.34%	23.01%	2.65%	1.47%	3.54%	0.00%	

Teacher Evaluation of IMPAC Programs
by Grade and Program Type
Grade 5

	frequency							
Item	6	5	4	3	2	1	0	Average
1 C-CAI	4	0	3	2	0	0	0	4.67
A-CAI	5	1	4	1	0	0	0	4.91
A-CMI/CAI	8	0	0	0	0	0	0	6.00
Total	17	1	7	3	0	0	0	5.14
2 C-CAI	3	1	4	1	0	0	0	4.67
A-CAI	7	2	2	1	0	0	0	5.25
A-CMI/CAI	4	0	2	1	0	0	0	5.00
Total	14	3	8	3	0	0	0	5.00
3 C-CAI	2	2	2	0	0	3	0	3.67
A-CAI	8	1	1	2	0	0	0	5.25
A-CMI/CAI	4	1	0	0	1	0	0	5.17
Total	14	4	3	2	1	3	0	4.70
4 C-CAI	3	2	3	0	0	0	0	5.00
A-CAI	4	0	5	0	0	0	0	4.89
A-CMI/CAI	3	2	2	1	0	0	0	4.88
Total	10	4	10	1	0	0	0	4.92
5 C-CAI	3	0	3	0	0	0	0	5.00
A-CAI	7	2	0	0	0	0	0	5.78
A-CMI/CAI	2	1	4	1	0	0	0	4.50
Total	12	3	7	1	0	0	0	5.13
6 C-CAI	1	7	0	0	0	0	0	5.13
A-CAI	4	4	1	0	0	0	0	5.33
A-CMI/CAI	4	0	2	0	1	0	0	4.86
Total	9	11	3	0	1	0	0	5.13
7 C-CAI	2	4	2	0	0	0	0	5.00
A-CAI	5	3	1	0	0	0	0	5.44
A-CMI/CAI	3	1	2	1	0	0	0	4.86
Total	10	8	5	1	0	0	0	5.13

				frequency					
Item		6	5	4	3	2	1	0	Average
8	C-CAI	1	2	4	0	0	0	0	4.57
	A-CAI	0	4	5	0	0	1	0	4.10
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	1	6	9	0	0	1	0	4.29
9	C-CAI	1	2	4	0	0	0	0	4.57
	A-CAI	1	2	7	0	0	0	0	4.40
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	2	4	11	0	0	0	0	4.47
10	C-CAI	1	5	1	0	0	0	0	5.00
	A-CAI	2	3	4	0	1	0	0	4.50
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	3	8	5	0	1	0	0	4.71
11	C-CAI	3	2	2	0	0	0	0	5.14
	A-CAI	3	3	3	0	1	1	0	4.36
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	6	5	5	0	1	1	0	4.67
12	C-CAI	4	2	1	0	2	0	0	4.67
	A-CAI	9	2	0	1	0	0	0	5.58
	A-CMI/CAI	3	3	0	0	0	0	0	5.50
	Total	16	7	1	1	2	0	0	5.26
13	C-CAI	4	1	4	0	0	0	0	5.00
	A-CAI	8	2	2	0	0	0	0	5.50
	A-CMI/CAI	3	0	3	0	0	0	0	5.00
	Total	15	3	9	0	0	0	0	5.22
14	C-CAI	6	0	3	0	0	0	0	5.33
	A-CAI	7	1	4	0	0	0	0	5.25
	A-CMI/CAI	4	1	2	0	0	0	0	5.29
	Total	17	2	9	0	0	0	0	5.29
Overall	C-CAI	40	30	36	3	2	3	0	4.82
	%	35.09%	26.32%	31.58%	2.63%	1.75%	2.63%	0.00%	
	A-CAI	70	30	39	5	3	1	0	5.05
	%	47.30%	20.27%	26.35%	3.38%	2.03%	0.68%	0.00%	
	A-CMI/CAI	38	9	17	4	2	0	0	5.10
	%	54.29%	12.86%	24.29%	5.71%	2.86%	0.00%	0.00%	
	Total	148	69	92	12	7	4	0	4.98
	%	44.58%	20.78%	27.71%	3.61%	2.11%	1.20%	0.00%	

Teacher Evaluation of IMPAC Programs
by Grade and Program Type
Grade 6

Item	frequency							
	6	5	4	3	2	1	0	Average
1 C-CAI	5	2	2	0	0	0	0	5.33
A-CAI	5	0	7	0	0	0	0	4.83
A-CMI/CAI	7	0	1	0	0	0	0	5.75
Total	17	2	10	0	0	0	0	5.24
2 C-CAI	4	2	3	0	0	0	0	5.11
A-CAI	8	1	2	1	0	0	0	5.33
A-CMI/CAI	3	2	3	0	0	0	0	5.00
Total	15	5	8	1	0	0	0	5.17
3 C-CAI	3	2	3	0	1	3	0	3.75
A-CAI	11	0	1	0	0	0	0	5.83
A-CMI/CAI	6	0	2	0	0	0	0	5.50
Total	20	2	6	0	1	3	0	4.97
4 C-CAI	2	2	3	0	0	0	0	4.86
A-CAI	8	0	2	0	0	0	0	5.60
A-CMI/CAI	5	0	3	0	0	0	0	5.25
Total	15	2	8	0	0	0	0	5.28
5 C-CAI	5	2	0	0	0	0	0	5.71
A-CAI	8	1	1	0	0	0	0	5.70
A-CMI/CAI	7	0	0	0	0	0	0	6.00
Total	20	3	1	0	0	0	0	5.79
6 C-CAI	1	5	1	0	0	0	0	5.00
A-CAI	7	1	1	1	0	0	0	5.40
A-CMI/CAI	3	5	0	0	0	0	0	5.38
Total	11	11	2	1	0	0	0	5.28
7 C-CAI	3	3	1	0	0	0	0	5.29
A-CAI	5	2	2	0	1	0	0	5.00
A-CMI/CAI	5	3	0	0	0	0	0	5.63
Total	13	8	3	0	1	0	0	5.28

		frequency							
Item		6	5	4	3	2	1	0	Average
8	C-CAI	1	1	5	0	0	1	0	4.00
	A-CAI	3	1	5	0	1	0	0	4.50
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	4	2	10	0	1	1	0	4.28
9	C-CAI	3	2	3	0	0	0	0	5.00
	A-CAI	5	1	4	0	0	0	0	5.10
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	8	3	7	0	0	0	0	5.06
10	C-CAI	2	2	4	0	0	0	0	4.75
	A-CAI	2	4	3	1	0	0	0	4.70
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	4	6	7	1	0	0	0	4.72
11	C-CAI	1	3	4	0	0	0	0	4.63
	A-CAI	3	2	4	1	0	0	0	4.70
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	4	5	8	1	0	0	0	4.67
12	C-CAI	5	2	1	1	0	0	0	5.22
	A-CAI	9	1	1	0	0	0	0	5.73
	A-CMI/CAI	3	4	1	0	0	0	0	5.25
	Total	17	7	3	1	0	0	0	5.43
13	C-CAI	3	2	4	0	0	0	0	4.89
	A-CAI	11	0	1	0	0	0	0	5.83
	A-CMI/CAI	2	1	4	0	0	1	0	4.25
	Total	16	3	9	0	0	1	0	5.10
14	C-CAI	7	0	2	0	0	0	0	5.56
	A-CAI	9	0	1	0	0	1	0	5.36
	A-CMI/CAI	2	3	2	0	0	1	0	4.50
	Total	18	3	5	0	0	2	0	5.18
Overall	C-CAI	45	30	36	1	1	4	0	4.90
	%	38.46%	25.64%	30.77%	0.85%	0.85%	3.42%	0.00%	
	A-CAI	94	14	35	4	2	1	0	5.27
	%	62.67%	9.33%	23.33%	2.67%	1.33%	0.67%	0.00%	
	A-CMI/CAI	43	18	16	0	0	2	0	5.24
	%	54.43%	22.78%	20.25%	0.00%	0.00%	2.53%	0.00%	
	Total	182	62	87	5	3	7	0	5.14
	%	52.60%	17.92%	25.14%	1.45%	0.87%	2.02%	0.00%	

Teacher Evaluation of Impac Programs
Commodore CAI, Apple CAI, Apple CMI/CAI
Grades 4, 5, 6

	frequency							
Item	6	5	4	3	2	1	0	Average
1 C-CAI	17	2	7	2	0	0	0	5.21
A-CAI	16	3	15	1	0	0	0	4.97
A-CMI/CAI	19	0	1	0	0	0	0	5.90
Total	52	5	23	3	0	0	0	5.28
2 C-CAI	9	4	12	3	0	0	0	4.68
A-CAI	27	3	4	2	0	0	0	5.53
A-CMI/CAI	8	3	6	1	0	1	0	4.79
Total	44	10	22	6	0	1	0	5.07
3 C-CAI	6	6	9	2	1	7	0	3.77
A-CAI	27	2	5	2	0	0	0	5.50
A-CMI/CAI	13	1	3	0	1	0	0	5.39
Total	46	9	17	4	2	7	0	4.85
4 C-CAI	12	4	8	0	0	0	0	5.17
A-CAI	23	1	7	0	0	0	0	5.52
A-CMI/CAI	11	2	6	1	0	0	0	5.15
Total	46	7	21	1	0	0	0	5.31
5 C-CAI	14	3	5	0	0	0	0	5.41
A-CAI	26	4	1	0	0	0	0	5.81
A-CMI/CAI	11	2	4	1	0	1	0	5.05
Total	51	9	10	1	0	1	0	5.49
6 C-CAI	6	17	1	0	0	0	0	5.21
A-CAI	21	7	2	1	0	0	0	5.55
A-CMI/CAI	7	8	3	0	1	0	0	5.05
Total	34	32	6	1	1	0	0	5.31
7 C-CAI	9	10	5	0	0	0	0	5.17
A-CAI	20	5	5	0	1	0	0	5.39
A-CMI/CAI	10	5	2	1	0	0	0	5.33
Total	39	20	12	1	1	0	0	5.30

Item		frequency							
		6	5	4	3	2	1	0	Average
8	C-CAI	3	4	14	0	0	3	0	4.04
	A-CAI	8	7	14	0	1	2	0	4.47
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	11	11	28	0	1	5	0	4.29
9	C-CAI	7	6	9	0	0	2	0	4.58
	A-CAI	9	5	17	0	0	1	0	4.63
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	16	11	26	0	0	3	0	4.61
10	C-CAI	8	8	6	0	2	0	0	4.83
	A-CAI	6	10	12	2	2	0	0	4.50
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	14	18	18	2	4	0	0	4.64
11	C-CAI	8	5	8	1	2	0	0	4.67
	A-CAI	9	7	11	3	1	2	0	4.42
	A-CMI/CAI	0	0	0	0	0	0	0	0.00
	Total	17	12	19	4	3	2	0	4.53
12	C-CAI	14	8	3	1	2	0	0	5.11
	A-CAI	26	5	2	2	0	0	0	5.57
	A-CMI/CAI	7	10	1	0	0	0	0	5.33
	Total	47	23	6	3	2	0	0	5.36
13	C-CAI	9	4	11	0	0	2	0	4.62
	A-CAI	23	3	10	0	0	0	0	5.36
	A-CMI/CAI	7	2	8	0	0	1	0	4.72
	Total	39	9	29	0	0	3	0	4.98
14	C-CAI	20	1	7	0	0	0	0	5.46
	A-CAI	27	1	6	0	0	1	0	5.49
	A-CMI/CAI	8	5	5	0	0	1	0	4.95
	Total	55	7	18	0	0	2	0	5.35
Overall	C-CAI	142	82	105	9	7	14	0	4.84
	%	39.55	22.84	29.25	2.51	1.95	3.90	0.00	
	A-CAI	268	63	111	13	5	4	0	5.22
	%	57.76	13.58	23.92	2.80	1.08	0.86	0.00	
	A-CMI/CAI	101	38	39	4	2	4	0	5.17
	%	53.72	20.21	20.74	2.13	1.06	2.13	0.00	
	Total	511	183	255	26	14	22	0	5.07
	%	50.54	18.10	25.22	2.57	1.38	2.18	0.00	

Teacher Evaluation of Impac Programs
by Grade
All Programs

				frequency					
Item		6	5	4	3	2	1	0	Average
1	4th Grade	18	2	6	0	0	0	0	5.46
	5th Grade	17	1	7	3	0	0	0	5.14
	6th Grade	17	2	10	0	0	0	0	5.24
	Total	52	5	23	3	0	0	0	5.28
2	4th Grade	15	2	6	2	0	1	0	5.04
	5th Grade	14	3	8	3	0	0	0	5.00
	6th Grade	15	5	8	1	0	0	0	5.17
	Total	44	10	22	6	0	1	0	5.07
3	4th Grade	12	3	8	2	0	1	0	4.85
	5th Grade	14	4	3	2	1	3	0	4.70
	6th Grade	20	2	6	0	1	3	0	4.97
	Total	46	9	17	4	2	7	0	4.85
4	4th Grade	21	1	3	0	0	0	0	5.72
	5th Grade	10	4	10	1	0	0	0	4.92
	6th Grade	15	2	8	0	0	0	0	5.28
	Total	46	7	21	1	0	0	0	5.31
5	4th Grade	19	3	2	0	0	1	0	5.52
	5th Grade	12	3	7	1	0	0	0	5.13
	6th Grade	20	3	1	0	0	0	0	5.79
	Total	51	9	10	1	0	1	0	5.49
6	4th Grade	14	10	1	0	0	0	0	5.52
	5th Grade	9	11	3	0	1	0	0	5.13
	6th Grade	11	11	2	1	0	0	0	5.28
	Total	34	32	6	1	1	0	0	5.31
7	4th Grade	16	4	4	0	0	0	0	5.50
	5th Grade	10	8	5	1	0	0	0	5.13
	6th Grade	13	8	3	0	1	0	0	5.28
	Total	39	20	12	1	1	0	0	5.30

		frequency							
Item		6	5	4	3	2	1	0	Average
8	4th Grade	6	3	9	0	0	3	0	4.29
	5th Grade	1	6	9	0	0	1	0	4.29
	6th Grade	4	2	10	0	1	1	0	0.00
	Total	11	11	28	0	1	5	0	4.29
9	4th Grade	6	4	8	0	0	3	0	4.33
	5th Grade	2	4	11	0	0	0	0	4.47
	6th Grade	8	3	7	0	0	0	0	0.00
	Total	16	11	26	0	0	3	0	4.61
10	4th Grade	7	4	6	1	3	0	0	4.52
	5th Grade	3	8	5	0	1	0	0	4.71
	6th Grade	4	6	7	1	0	0	0	0.00
	Total	14	18	18	2	4	0	0	4.64
11	4th Grade	7	2	6	3	2	1	0	4.29
	5th Grade	6	5	5	0	1	1	0	4.67
	6th Grade	4	5	8	1	0	0	0	0.00
	Total	17	12	19	4	3	2	0	4.53
12	4th Grade	14	9	2	1	0	0	0	5.38
	5th Grade	16	7	1	1	2	0	0	5.26
	6th Grade	17	7	3	1	0	0	0	5.43
	Total	47	23	6	3	2	0	0	5.36
13	4th Grade	8	3	11	0	0	2	0	4.54
	5th Grade	15	3	9	0	0	0	0	5.22
	6th Grade	16	3	9	0	0	1	0	5.10
	Total	39	9	29	0	0	3	0	4.98
14	4th Grade	20	2	4	0	0	0	0	5.62
	5th Grade	17	2	9	0	0	0	0	5.29
	6th Grade	18	3	5	0	0	2	0	5.18
	Total	55	7	18	0	0	2	0	5.35
Overall	4th Grade	183	52	76	11	5	12	0	5.06
	%	53.98%	15.34%	22.42%	3.24%	1.47%	3.54%	0.00%	
	5th Grade	146	69	92	12	7	5	0	4.97
	%	44.11%	20.85%	27.79%	3.63%	2.11%	1.51%	0.00%	
	6th Grade	182	62	87	5	3	7	0	5.14
	%	52.60%	17.92%	25.14%	1.45%	0.87%	2.02%	0.00%	
	Total	511	183	255	28	15	24	0	5.06
	%	50.30%	18.01%	25.10%	2.76%	1.48%	2.36%	0.00%	

ANALYSIS OF HARDWARE AND SOFTWARE MAINTENANCE COST

Three vendors were responsible for hardware and software service once the warranty period expired. The warranty period for the Commodore 64 equipment was 12 months. The warranty period for the Apple IIe hardware was 90 days. The procedure for securing repairs is outlined in the letter at the end of this section. Defective software disks were replaced following the policy of each company. All repair requests were processed through the IMPAC office in Little Rock and monitored as to cost and the nature of the repair.

The maintenance for the Apple IIe - Corvus network was covered under a contract with the vendor that received the equipment bid. The current cost is $5320 per system and is expected to be $4200 or less for the network systems installed during 1985-86.

In general, IMPAC recommends that $40.00 per computer system (computer, monitor and disk drive) be budgeted each year for repairs. For 24 systems this would be $960.00. Beginning in the school-year 1986-87 a hardware and software service contract for a 24 system Apple IIe, Corvus Omni network should not exceed $3600.00 per year and should include complete software and hardware service on-site with minimal downtime. That figure in Arkansas is expected to decrease to $2700.00 by 1987 for IMPAC project schools.

Significant Software and Hardware Problems

The Commodore warranty procedure and the electrical problems associated with the Apple IIe Corvus network presented major obstacles to the success of IMPAC during 1983-85. However, adjustments were made rapidly in most cases and efforts by the IMPAC staff to solve problems were clearly evident at all project sites.

The vendor that received the largest volume Commodore equipment bid used direct delivery of replacement units (disk drives, power packs, monitors and computers) to the Commodore CAI schools as the method of repair. This was suitable until replacement units were unavailable. All equipment under warranty was returned to a Commodore national repair center and repairs required up to 90 days. The vendor was extremely helpful in securing several replacement units; however, for several months the service was slow due to the warranty policy of Commodore. The 1541 disk drives and power packs had a high defective rate. After the one-year warranty period ended an effective repair procedure was implemented using a local vendor and transporting the equipment via United Parcel Service (UPS). Since the warranty period for the Apple IIe equipment was 90 days, IMPAC implemented the use of UPS in transporting defective equipment between the school and the vendor immediately after the end of warranty.

The Apple IIe network problems were electrical or software related. Induced current, improper installation of electrical grounds and power surges created major problems at all but one of the six CMI-CAI sites. An

Educational Technologist was employed in August 1984 to work directly with school districts on all matters related to installation of equipment. The software problems stemmed primarily from the mapping of supplementary objectives to objectives in the CMI-CAI management system for the delivery of lessons assigned by the teachers on a weekly basis. The contractor responsible for keying in the supplementary lessons to appropriate objectives made numerous errors which were not immediately corrected due to the company's inability to respond to problems. Also, the lack of reading and language arts courseware for the hard disk has limited the CMI-CAI system use in that area.

The software package for the CMI-CAI network for 1985-87 will include Mathware I, II, III, Readware, Ideal Learning's Mathematics and Language Arts program and San Diego Mathematics program keyed into the Mathware objectives. Also, plans are being made to develop Mathware IV-V through Essertier, Inc. and a 54 lesson science program through the Center for Interactive Technology, University of Arkansas, Fayetteville, Arkansas.

Commodore Hardware Defective Rate

	Number	Number Repaired	%	Average Cost/Unit	Total
Disk Drive	148	55	37.2	$50	$2750
Monitor	148	6	4.1	50	300
CPU	148	20	13.5	40	800
Printer	27	3	11.1	50	150
Power Pack	148	19	12.8	35	665
Keyboard	148	4	2.7	40	160
					$4825

Cost per system for 12 months $\frac{\$4825}{148} = \$32.60$

Some of these repairs were covered under warranty. The actual cost to IMPAC was $1633.67

Apple Hardware Defective Rate

	Number	Number Repaired	%	Average Cost/Unit	Total
Disk Drive	152	25	16.4	$65	$1625
Monitor	152	9	5.9	65	585
CPU	152	16	10.5	65	1040
Printer	36	1	2.8	65	65
Keyboard	152	2	1.3	45	90
					$3405

Cost per system 12 months $\frac{\$3405}{152} = \$22.40$

Some of these repairs were covered under warranty. The actual cost to IMPAC was $1397.37.

The data on the preceding page are based on reports from 7 Commodore CAI and 7 Apple IIe CAI project schools.

The hardware maintenance for the CMI-CAI Apple IIe network programs was $18,500 or $3,008.33 per site. The cost for the software support contract for the six CMI-CAI Apple IIe network programs was $13,980 or $2,330 per school year. The 1985-86 maintenance cost for ten programs is projected to be $3600.00 per site.

An overall defective rate during warranty and after warranty is computed below:

Equipment Repaired During Warranty Period

	Months under Warranty	# System Components	#of Components Repaired	Defective Rate
Apple IIe Systems	3	492	23	4.7
Commodore 64 Syst.	12	471	72	15.3

Equipment Repaired After Warranty Period

	Months out of Warranty	# System Components	#of Components Repaired	Defective Rate
Apple IIe Systems	15	492	30	6.1
Commodore 64 Syst.	6	471	35	7.4

Equipment Repaired During and After Warranty Period

	Equipment Months	# System Components	#of Components Repaired	Defective Rate 18 Mo.	Estimate Defective Rate 12 Mo.
Apple IIe Systems	18	492	53	10.8	7.2
Commodore 64 Syst.	18	471	107	22.7	15.1

This data provides a means of estimating the cost of the repairs of Commodore 64 and Apple IIe stand alone microcomputer systems.

A typical Commodore and Apple CAI project involves 24 microcomputer systems and 6 printers. Since each system has a CPU, monitor and disk drive, there are (24x3)+6=78 components being used by the students. The expected number of units that will be defective during a 12 month period is computed as follows for the Commodore-64 and Apple IIe systems:

Apple IIe	Commodore 64
78 X .072 = 6	78 X .151 = 12

If the average cost to repair an Apple IIe component is $65.00, the the expected cost for repairs is $65 x 6 = $395 per year. If the average cost to repair a Commodore 64 computer is $50, then the expected cost for repairs is $50 x 12 = $600. However, to be more realistic, and since the number of expected repairs can be associated with a Poisson distribution, we can obtain a 99% confidence limit to obtain a better figure to use in setting up a budget item for repairs.

A Poisson distribution with a expected value of 6 related to the Apple IIe system is such that 13 or fewer repairs will be expected 99% of the time each year. Therefore, a district should budget 13 x 65 = $845 per year or $35.00 per system.

A Poisson distribution with an expected value of 12 related to the Commodore 64 systems is such that 21 or fewer repairs will be expected 99% of the time each year. Therefore a district should budget 21 x 50 = $1050 per year or $43.75 per system.

The obvious difference in the defective rate of Commodore 64 systems and Apple IIe systems is quality control prior to installation. All systems must be checked carefully during the warranty period and if possible, prior to acceptance and initial payment for the equipment.

TO: Superintendent and Principal of IMPAC Project Schools

FROM: Cecil McDermott, IMPAC Project Director

DATE: March 13, 1985

SUBJECT: Maintenance Procedures for Commodore Computer Equipment *

Beginning March 18, 1985, this procedure will be used with respect to repairs on Commodore computer equipment purchased under IMPAC for use in your school.

If a computer, monitor, disk drive or printer needs repair, please use the following procedure:

1. Be sure that the piece of equipment is in need of repair. Exchange "good pieces" with suspected "defective pieces" until you are absolutely sure you have a problem.
2. In deciding if a piece of equipment is defective, be sure all the plugs are properly connected, dials on the monitors adjusted, etc.
3. To have a piece of equipment repaired, box it up for shipment and address it to:

   Company "X"
   Service Director
   Address
   City, State, Zip

4. Complete a checklist (copy enclosed) for each piece of equipment to be repaired. Send a copy of the checklist with the equipment in the package. Also send a copy of the checklist to Project IMPAC, State Department of Education, #4 Capitol Mall, Little Rock, AR 72201.
5. Call your local United Parcel Serivce (UPS) office for package pickup. UPS will need to know the number of packages and the weight of each. Determine the weight by using 11 pounds for a 1541 disk drive, 30 pounds for a monitor, 5 pounds for a power supply cord and 10 pounds for a Commodore 64 computer. No box may weigh more than 50 pounds and the total pickup order must be 100 pounds or less. The cost of shipping to Company "X" must be paid by the school district. (Approximately $5.00 per pick up.)
6. Company "X" will return the repaired equipment to you by UPS at no cost to the school district.

You should also continue to keep a record of the date when you send in equipment, as well as the serial numbers on the equipment sent and received.

Please keep a few boxes with appropriate packing available for shipment purposes. Remember, if you ship a computer in, please include the power supply cord. It is not necessary to send the cords with the monitors, disk drives or printers.

The procedure outlined in this letter is satisfactory with IMPAC and Company "X". If you have any questions, please call Danita Hyrkas, IMPAC Administrative Assistant, 371-1402.

* A similar procedure was followed related to Apple IIe equipment used in the Apple-CAI program.

Equipment Repair Checklist

Date____________________

School District_________________________ Telephone____________________

Address____

This checklist must accompany the unit that is being returned to Company "X" for repair.

Check the unit being returned and the most appropriate diagnosis:

______A. **COMPUTER**
(Power supply cord
must accompany computer)

Serial # _____________
Property #____________

_____1. Will not power up using a good power supply cord

_____2. Keyboard is defective
The specific keys are:
___, ___, ___, ___, ___

_____3. Computer comes on, but slowly goes down over time

_____4. Connection ports are defective or loose

______B. **POWER SUPPLY CORD**

_____1. Computer known to work - will not work when this power supply cord is used

_____C. **DISK DRIVE**
(Electrical cord
should not be sent.

Serial #_____________
Property #___________

_____1. Disk door fails to operate properly

_____2. Gives read or write errors when it trys to read software

_____3. Will not format a new disk

_____D. **PRINTER**
(Electrical cord
should not be sent)

Serial #_____________
Property #___________

_____1. Will not feed the paper properly

_____2. The following characters will not print on the paper:
___, ___, ___, ___, ___

Note: If printer works properly, but the print is light, please check the ribbon -- it may need to be replaced.

_____E. **MONITOR**
(electrical cord
should not be sent)

Serial #____________
Property #___________

_____1. The power up light will not come on

_____2. Screen lights up but it is wavy or flickers

_____3. *Video does not work properly

_____4. *Audio does not work properly

*Note: Check brightness level knob and volume level knob.

Other: If none of the above apply, please provide a brief description of the problem____

____

____

____

In case Company "X" needs more information, please provide the name and telephone number of the person familiar with the malfunction:

School District _____________________ Person to Contact_______________

Address____

Telephone number _____________________

SEND A COPY OF THIS COMPLETED CHECKLIST TO THE IMPAC OFFICE:

Project IMPAC
State Department of Education
#4 Capitol Mall
Little Rock, AR 72201

ANALYSIS OF ACHIEVEMENT SCORES IN MATHEMATICS, READING AND LANGUAGE ARTS

The following data provides a summary of the number of Experimental and Control group comparisions that were made by program type and grade level.

		Number of Comparisions and Students in Sample											
		C-CAI			A-CAI			A-CMI-CAI			C-AIM		
Grade	Subject	#	N(E)	N(C)	#	N(E)	N(C)	#	N(E)	N(C)	#	N(E)	N(C)
3	Reading	0	0	0	2	28	35	0	0	0	0	0	0
3	Math	0	0	0	1	14	17	0	0	0	3	53	60
3	Lang/Art	0	0	0	2	28	35	0	0	0	0	0	0
4	Reading	14	246	275	8	129	156	0	0	0	0	0	0
4	Math	15	284	314	5	98	91	6	151	139	2	47	40
4	Lang/Art	15	295	332	7	125	132	0	0	0	0	0	0
5	Reading	11	215	246	13	272	290	0	0	0	0	0	0
5	Math	7	124	165	6	114	121	5	148	103	2	47	29
5	Lang/Art	11	223	263	11	230	221	0	0	0	0	0	0
6	Reading	10	203	181	7	162	160	0	0	0	0	0	0
6	Math	15	338	293	10	229	255	6	204	133	1	24	18
6	Lang/Art	10	218	193	7	173	194	0	0	0	0	0	0
Reading	Total	35	664	702	30	591	641	0	0	0	0	0	0
Math	Total	37	746	772	22	455	484	17	503	375	8	171	147
Lan/Art	Total	36	736	788	27	556	582	0	0	0	0	0	0

The results of the IMPAC research are presented in detail in this section. The basic format for the presentation of results is clarified on the next page. The schools are coded, the subject indicated and various statistical results provided.

Descriptions Used in Column Headings

Index - Order in which classes are listed in chart

School - School and class code to retain confidentiality

Subject - M (Mathematics), R (Reading) and L (Language Arts)

ES% - Relates the ES value to the normal curve

D - Coefficient of determination

$\overline{ES}$ - Means Effect Size and is equal to

$$\frac{X(e) - X(c)}{Sp}$$

Unadjusted Gain - The difference in the average gains of the pre-test scores and the post-test scores for the experimental and control groups

Adjusted Gain - Is the same as the unadjusted gain when the Wilcoxon test was used or when the t test was used and no adjustment of pre-test scores was required using analysis of covariance. Adjusted gain and unadjusted gain differences resulted from the use of the analysis of covariance.

Evaluation - Refers to evaluation of the IMPAC program by the experimental teachers

Cycle - Refers to the number of times the student was on task in a cycle of 10 days

Time on Task - Reflects the average number of minutes each student worked on CAI lessons during the school year. Students sign on and off the computer and record the number of minutes worked. The time on task is the number of minutes that best represents the classes' time on task.

Grade - Grades 3, 4, 5 and 6 were indicated

N - The number of participants in the experimental and control groups is provided.

It should be noted that in the analysis of the data for school G1, two classes were pooled together in the report form since the experimental and control classes involved the same teachers.

Commodore CAI

Index	School	Subject	ES%	D	ES	Unadj. Gain	Adj. Gain	Eval	Cycle	Time On Task	Grade	N exp.	N con.
1	G1	M	64.47%	0.301	0.371	0.596	0.596		8	1620	6	49	49
2	E4	M	81.60%	0.750	0.900	0.940	0.765	4.9	7	1418	4	16	18
3	E4	R	77.72%	0.585	0.763	1.064	1.019	4.0	8	1440	4	16	13
4	E4	L	50.00%	0.778		0.467	0.488	4.0	8	1440	4	16	18
5	E4	L	50.00%	0.726		0.393	0.391	4.0	8	1440	4	16	13
6	E4	R	76.08%	0.635	0.709	1.464	1.464	4.0	8	1440	4	16	18
7	E4	M	50.00%	0.525		1.179	1.087	4.9	8	1620	4	16	13
8	E4	M	84.68%	0.400	1.023	1.160	1.160	4.9	7	1418	5	13	25
9	E4	M	96.00%	0.548	1.751	1.437	1.596	4.9	7	1418	5	19	27
10	E4	R	50.00%	0.635	0.000	0.511	0.512	4.0	8	1440	5	19	27
11	E4	L	56.83%	0.752	0.172	0.388	0.388	4.0	8	1440	5	19	27
12	E4	M	41.64%	0.576	-0.211	-0.347	-0.347	4.9	7	1418	6	25	27
13	E2	M	41.92%	0.412	-0.204	-0.240	-0.240	5.4	5	1013	4	12	15
14	E2	R	68.38%	0.482	0.478	0.406	0.546	5.3	7	1260	4	16	16
15	E2	R	69.63%	0.711	0.514	0.268	0.413	5.4	5	900	4	12	15
16	E2	M	73.10%	0.558	0.616	0.684	0.482	4.8	5	1013	5	14	15
17	E2	R	50.00%	0.623	0.000	0.280	0.228	4.7	4	720	5	14	15
18	E2	M	42.66%	0.585	-0.185	-0.371	-0.371	4.5	5	1013	6	20	11
19	E2	R	47.50%	0.787	-0.063	-0.103	-0.088	4.6	5	900	6	20	11
20	E3	M	45.86%	0.631	-0.104	-0.105	-0.089	5.3	5	1013	4	14	16
21	E3	M	51.32%	0.502	0.033	0.040	0.040	5.3	5	1013	4	14	24
22	E3	R	50.00%	0.644	0.000	0.060	0.004	4.7	5	900	4	16	21
23	E3	L	53.70%	0.761	0.093	0.195	0.195	5.0	5	900	4	14	16
24	E3	R	62.42%	0.658	0.316	0.346	0.317	5.0	5	900	4	14	16
25	E3	M	23.62%	0.381	-0.718	-0.702	-0.702	5.0	5	1013	4	16	21
26	E3	R	41.69%	0.639	-0.210	-0.345	-0.291	5.0	5	900	4	14	24
27	E3	L	49.32%	0.688	-0.017	-0.038	-0.038	4.7	5	900	4	16	21
28	E3	L	24.14%	0.755	-0.701	-0.853	-0.834	4.7	5	900	4	16	21
29	E3	R	66.84%	0.769	0.435	0.383	0.343	4.7	5	900	4	16	21
30	E3	L	70.29%	0.556	0.533	0.978	0.879	5.5	8	1440	5	16	23
31	E3	L	66.40%	0.448	0.423	0.908	0.664	5.5	8	1440	5	16	22
32	E3	R	60.12%	0.619	0.256	0.324	0.345	5.5	8	1440	5	16	22
33	E3	L	74.07%	0.651	0.646	0.895	0.857	4.4	8	1440	5	17	24
34	E3	L	60.01%	0.509	0.254	0.662	0.456	4.4	8	1440	5	17	22
35	E3	R	57.02%	0.635	0.177	0.187	0.254	4.4	8	1440	5	17	24
36	E3	M	55.47%	0.729	0.138	0.088	0.107	5.5	8	1620	5	16	22
37	E3	M	52.91%	0.687	0.073	0.007	0.064	5.5	8	1620	5	16	23
38	E3	R	61.93%	0.603	0.304	0.414	0.409	4.4	8	1440	5	17	22
39	E3	R	60.64%	0.801	0.270	0.608	0.608	5.5	8	1440	5	16	23
40	E3	R	35.94%	0.598	-0.360	-0.596	-0.549	5.3	8	1440	6	22	26
41	E3	R	75.07%	0.716	0.677	0.725	0.794	5.3	8	1440	6	22	23
42	E3	M	66.87%	0.603	0.436	0.392	0.372	5.4	8	1620	6	22	23
43	E3	R	72.08%	0.706	0.585	0.861	0.889	5.5	8	1440	6	24	28
44	E3	L	45.30%	0.773	-0.118	-0.343	-0.343	5.5	8	1440	6	24	28
45	E3	M	70.25%	0.612	0.532	0.612	0.607	5.5	8	1620	6	24	24
46	E3	R	74.59%	0.703	0.662	0.854	0.873	5.5	8	1440	6	24	24
47	E3	L	47.77%	0.677	-0.056	-0.079	-0.088	5.5	8	1440	6	24	24
48	E3	L	67.26%	0.824	0.447	0.453	0.462	5.3	8	1440	6	22	23
49	E3	M	57.25%	0.646	0.183	0.217	0.216	5.5	8	1620	6	24	28
50	E3	L	47.93%	0.775	-0.052	-0.144	-0.144	5.3	8	1440	6	22	26
51	E5	L	51.48%	0.715	0.037	0.100	0.100	3.5	6	1080	4	23	24
52	E5	R	60.80%	0.715	0.274	0.597	0.597	3.5	6	1080	4	23	24
53	E5	L	59.69%	0.783	0.245	0.293	0.332	3.4	6	1080	4	26	23
54	E5	M	56.63%	0.609	0.167	0.232	0.232	4.7	6	1215	4	23	24

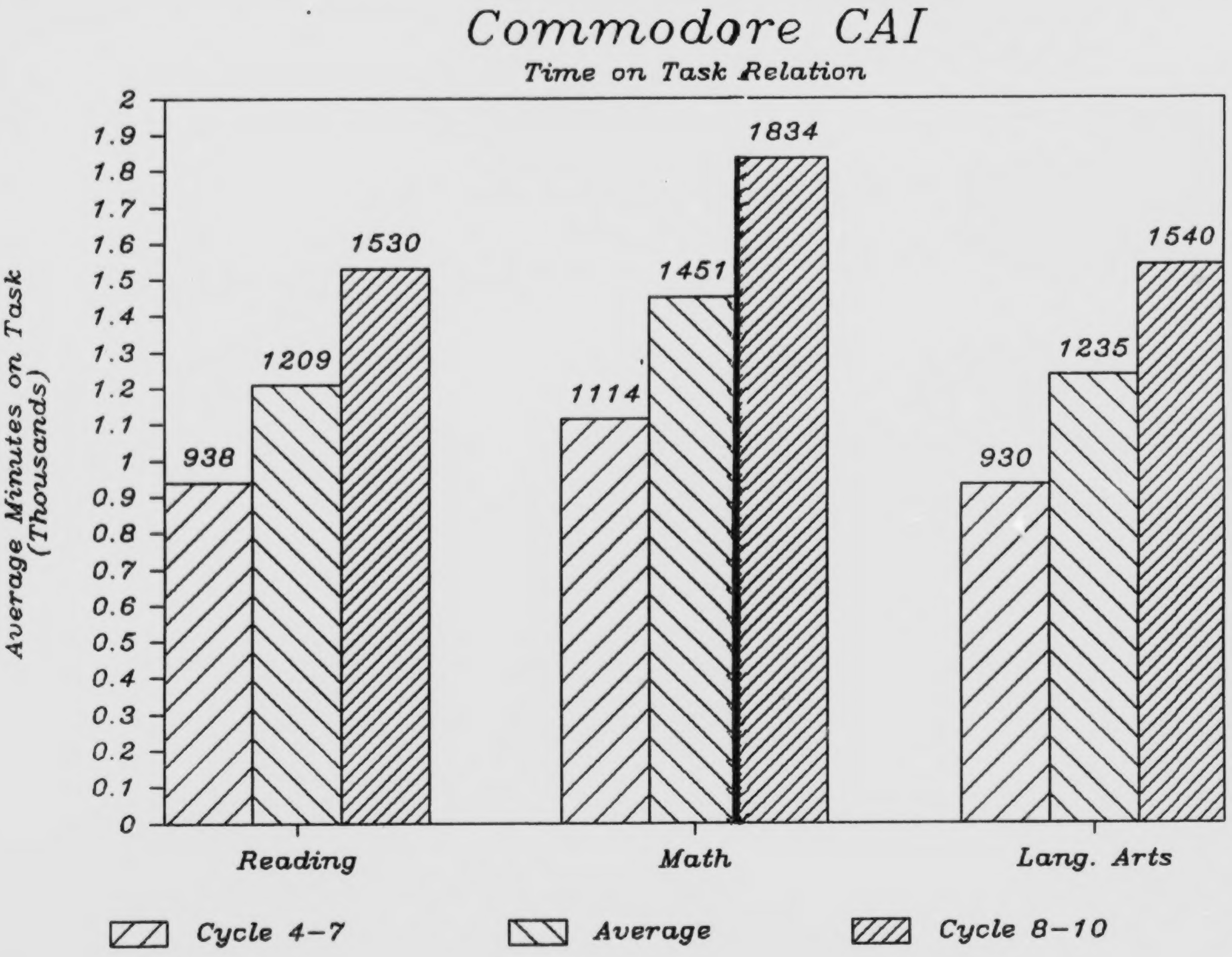
Commodore CAI

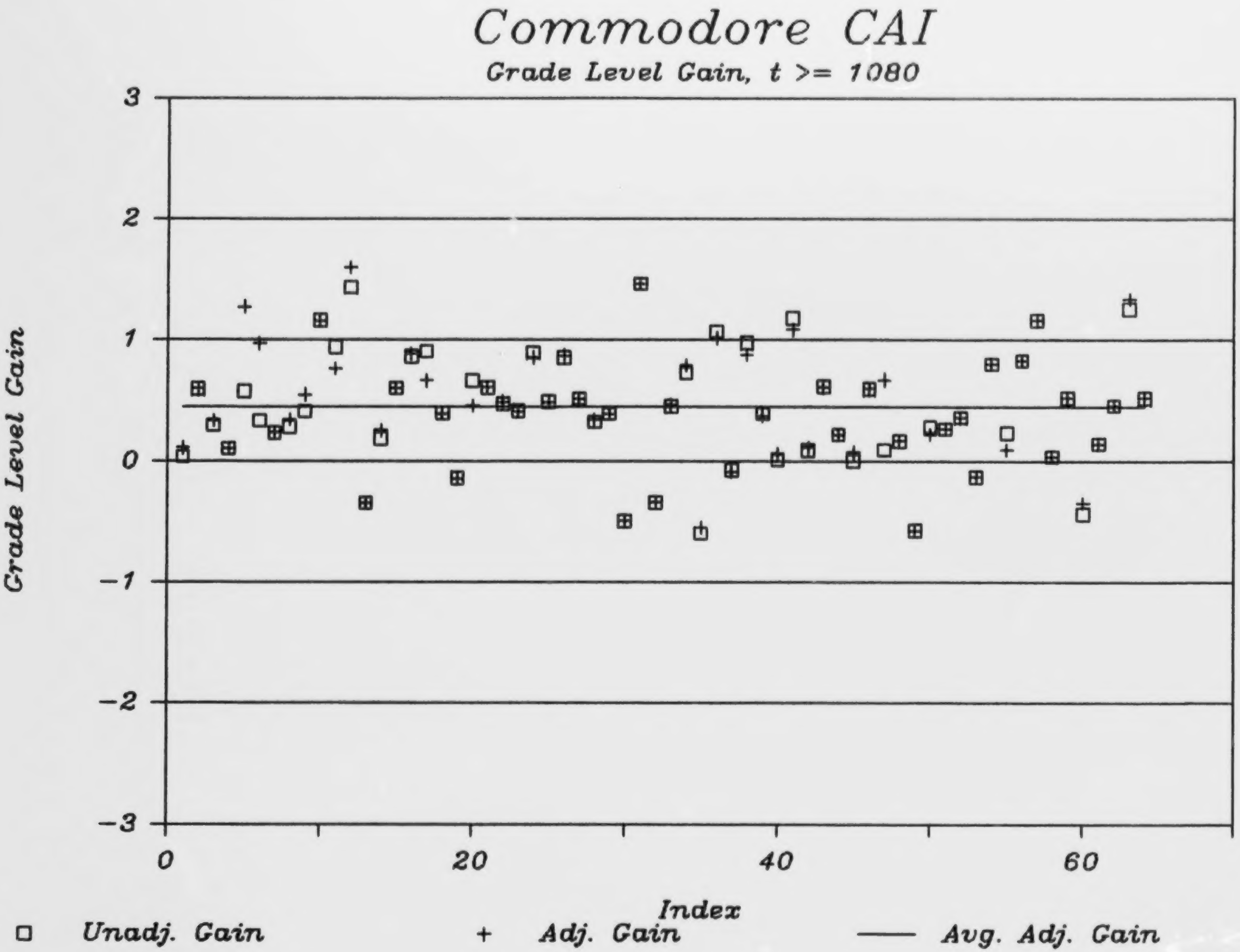
Index	School	Subject	ES%	D	ES	Unadj. Gain	Adj. Gain	Eval	Cycle	Time On Task	Grade	N exp.	N con.
55	E5	R	54.52%	0.797	0.114	0.033	0.107	3.4	6	1080	4	26	22
56	E5	M	65.01%	0.704	0.386	0.278	0.340	4.7	6	1215	4	26	23
57	E5	L	44.80%	0.422	-0.131	-0.192	-0.206	4.8	5	900	5	25	21
58	E5	L	60.24%	0.505	0.260	0.191	0.380	4.8	5	900	5	23	23
59	E5	R	58.45%	0.602	0.213	0.217	0.287	4.8	5	900	5	23	23
60	E5	R	80.03%	0.529	0.843	0.575	1.276	4.8	6	1080	5	22	23
61	E5	R	50.00%	0.479		0.462	0.408	4.8	5	900	5	23	21
62	E5	L	47.97%	0.289	-0.051	-0.094	-0.094	4.8	5	900	5	24	21
63	E5	R	52.15%	0.387	0.054	0.080	0.080	4.8	5	900	5	24	21
64	E5	M	45.30%	0.196	-0.118	-0.145	-0.145	4.8	5	1013	5	24	21
65	E5	L	73.98%	0.448	0.643	0.331	0.970	4.8	6	1080	5	22	23
66	E5	M	62.55%	0.368	0.320	0.439	0.439	5.3	5	1013	6	17	9
67	E5	L	66.75%	0.472	0.433	0.096	0.671	4.9	10	1800	6	20	17
68	E5	L	51.59%	0.683	0.040	0.108	0.108	4.9	5	900	6	23	9
69	E5	M	69.78%	0.181	0.518	0.518	0.518	5.3	10	2025	6	15	18
70	E5	R	53.17%	0.491	0.080	0.233	0.092	4.9	10	1800	6	15	18
71	E5	M	84.52%	0.485	1.016	1.257	1.337	5.3	10	2025	6	22	9
72	E5	L	44.90%	0.665	-0.128	-0.194	-0.188	4.9	5	900	6	21	18
73	E5	L	41.63%	0.489	-0.211	-0.342	-0.353	4.9	5	900	6	17	9
74	E5	L	58.01%	0.673	0.202	0.355	0.316	4.9	5	900	6	22	9
75	E5	M	64.69%	0.579	0.377	0.519	0.519	5.3	10	2025	6	24	18
76	E5	M	47.21%	0.397	-0.070	-0.111	-0.111	5.3	5	1013	6	9	9
77	E5	M	68.51%	0.507	0.482	0.830	0.830	5.3	10	2025	6	20	17
78	E5	R	32.76%	0.453	-0.446	-0.711	-0.498	4.9	5	900	6	9	9
79	E5	M	72.57%	0.409	0.600	1.163	1.163	5.3	10	2025	6	23	9
80	E5	M	62.93%	0.661	0.330	0.456	0.456	5.3	10	2025	6	21	18
81	E5	R	62.07%	0.647	0.307	0.521	0.502	4.9	5	900	6	21	9
82	E5	R	47.19%	0.830	-0.071	-0.097	-0.072	4.9	5	900	6	23	9
83	E1	L	40.95%	0.422	-0.229	-0.362	-0.373	4.8	5	900	4	26	26
84	E1	L	64.08%	0.588	0.361	0.628	0.465	4.8	5	900	4	18	18
85	E1	M	49.71%	0.227	-0.007	0.051	0.051	5.3	5	1013	4	26	30
86	E1	L	70.26%	0.618	0.532	0.907	0.907	4.8	5	900	4	18	15
87	E1	M	34.64%	0.312	-0.395	-0.439	-0.347	5.3	10	2025	4	18	19
88	E1	R	63.53%	0.072	0.346	0.362	0.362	4.8	10	1800	4	18	22
89	E1	L	55.65%	0.472	0.142	0.282	0.216	4.8	10	1800	4	22	30
90	E1	M	50.42%	0.415	0.011	-0.022	0.007	5.3	5	1013	4	18	18
91	E1	L	77.79%	0.055	0.765	0.803	0.803	4.8	10	1800	4	18	22
92	E1	M	55.37%	0.176	0.135	0.139	0.139	5.3	10	2025	4	23	30
93	E1	R	78.04%	0.618	0.774	0.769	0.794	4.8	5	900	4	18	15
94	E1	R	46.33%	0.327	-0.092	-0.131	-0.131	4.0	10	1800	4	23	30
95	E1	L	67.84%	0.487	0.463	0.650	0.613	4.8	5	900	4	26	30
96	E1	R	55.41%	0.197	0.136	0.167	0.167	4.8	10	1800	4	18	19
97	E1	L	36.86%	0.456	-0.335	-0.574	-0.580	4.8	10	1800	4	22	26
98	E1	M	51.28%	0.208	0.032	0.034	0.034	5.3	10	2025	4	18	22
99	E1	M	40.55%	0.366	-0.239	-0.273	-0.273	5.3	5	1013	4	26	26
100	E1	M	61.03%	0.183	0.280	0.234	0.234	5.3	5	1013	4	18	15
101	E1	L	58.55%	0.324	0.216	0.263	0.263	4.8	10	1800	4	18	19
102	E1	L	64.21%	0.120	0.364	0.488	0.488	0.0	8	1440	5	22	32
103	E1	M	52.95%	0.372	0.074	0.005	0.070	5.7	8	1620	5	22	32
104	E1	L	66.93%	0.233	0.438	0.600	0.600		8	1440	5	22	25
105	E1	R	36.02%	0.365	-0.358	-0.496	-0.496		8	1440	5	22	25
106	E1	M	37.95%	0.415	-0.307	-0.361	-0.315		5	1013	6	23	24
107	E1	L	58.16%	0.205	0.206	0.384	0.384	4.7	5	900	6	23	30
108	E1	R	44.79%	0.252	-0.131	-0.220	-0.220	4.7	5	900	6	23	24

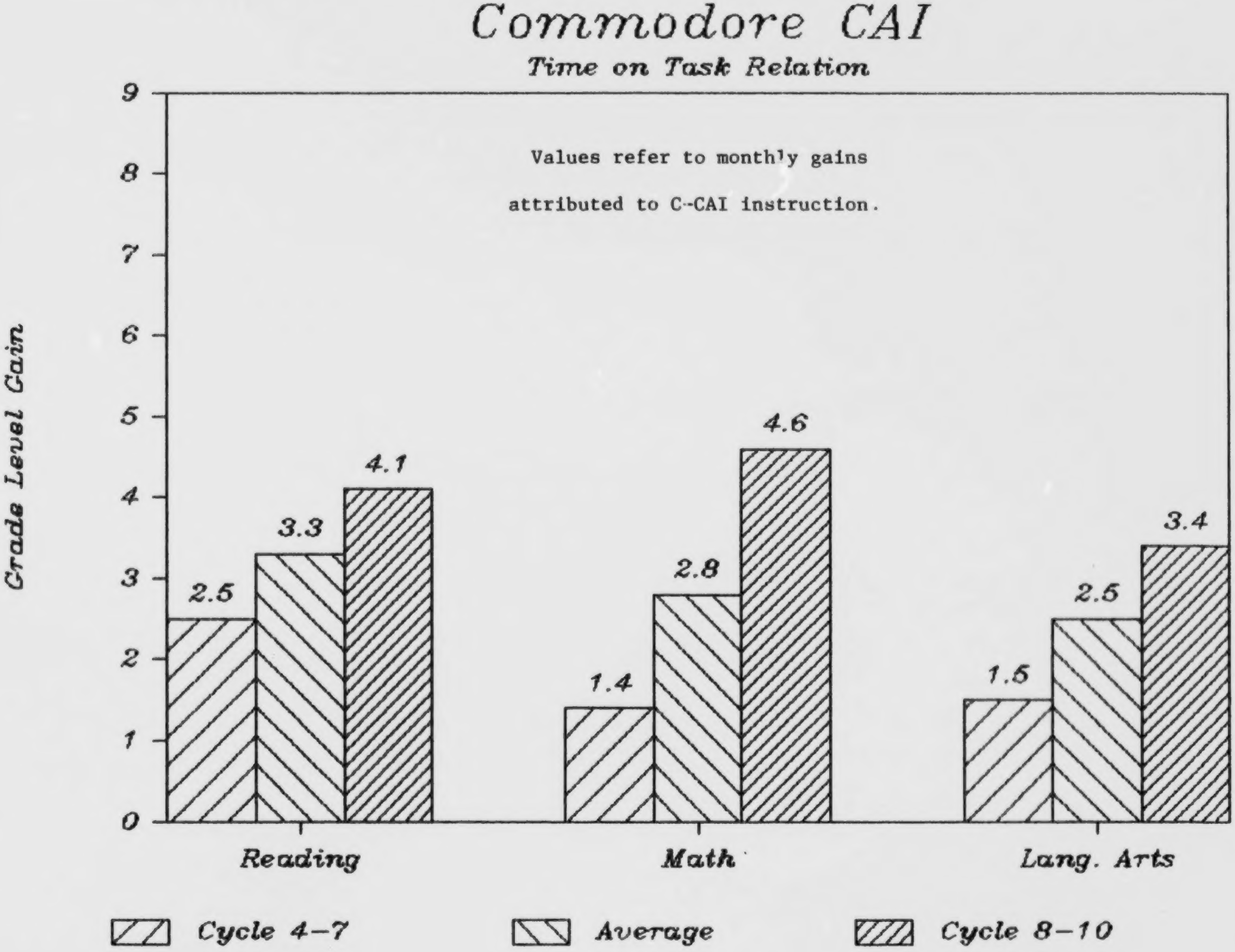
Summary of Commodore CAI

Subject	ES	Unadj. Gain	Adj. Gain
4th Grade Reading	0.326	0.389	0.408
4th Grade Math	0.020	0.090	0.085
4th Grade Language Arts	0.121	0.210	0.197
5th Grade Reading	0.176	0.287	0.355
5th Grade Math	0.508	0.462	0.476
5th Grade Language Arts	0.323	0.469	0.489
6th Grade Reading	0.124	0.147	0.172
6th Grade Math	0.293	0.387	0.394
6th Grade Language Arts	0.076	0.029	0.082
Total Reading	0.222	0.288	0.324
Total Math	0.228	0.281	0.284
Total Language Arts	0.173	0.239	0.254
Adj. Total Reading	0.293	0.408	0.457
Adj. Total Math	0.405	0.490	0.501
Adj. Total Language Arts	0.273	0.346	0.375

Adjusted totals refer to averages based on classes where time on task was >= 1080 minutes.


Commodore CAI
Time on Task Relation
Average Minutes on Task
(Thousands)
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
938
1209
1530
1114
1451
1834
930
1235
1540
Reading
Math
Lang. Arts
Cycle 4-7
Average
Cycle 8-10


Commodore CAI
Grade Level Gain, t >= 1080
3
2
1
0
−1
−2
−3
Grade Level Gain
0
20
40
60
Index
Unadj. Gain
Adj. Gain
Avg. Adj. Gain



Values refer to monthly gains attributed to C-CAI instruction.

Apple CAI

Index	School	Subject	ES%	D	ES	Unadj. Gain	Adj. Gain	Eval	Cycle	Time on Task	Grade	N exp.	N con.
1	C2	M	63.40%	0.676	0.342	0.121	0.334	5.8	8	1620	4	18	16
2	C2	L	69.64%	0.600	0.514	0.734	0.802	5.0	5	900	4	18	16
3	C2	R	50.00%	0.400	0.000	-0.305	-0.131	4.9	5	900	5	35	24
4	C2	R	41.72%	0.557	-0.209	-0.429	-0.429	4.9	5	900	5	24	24
5	C2	R	39.17%	0.627	-0.275	-0.360	-0.347	5.3	5	900	5	19	26
6	C2	R	37.58%	0.584	-0.316	-0.424	-0.420	5.3	5	900	5	33	26
7	C2	L	40.54%	0.703	-0.239	-0.404	-0.365	5.3	5	900	5	33	26
8	C2	R	26.13%	0.714	-0.639	-0.982	-0.965	4.8	5	900	6	18	31
9	C2	M	24.81%	0.768	-0.680	-0.798	-0.820	5.1	5	1013	6	18	31
10	C2	L	52.03%	0.704	0.051	0.177	0.177	4.8	5	900	6	18	31
11	C2	L	59.86%	0.692	0.250	0.323	0.387	4.8	5	900	6	34	31
12	C2	R	36.88%	0.717	-0.335	-0.978	-0.978	4.8	5	900	6	24	29
13	C2	M	29.62%	0.592	-0.535	-0.806	-0.817	5.1	5	1013	6	24	29
14	C2	L	48.04%	0.753	-0.049	-0.026	-0.071	4.8	5	900	6	24	29
15	C2	M	37.73%	0.607	-0.313	-0.489	-0.475	5.1	5	1013	6	24	29
16	C2	L	36.19%	0.732	-0.353	-0.467	-0.492	4.8	5	900	6	24	29
17	D1	M	30.57%	0.550	-0.508	-0.544	-0.544		4	810	5	15	24
18	C6	M	58.20%	0.580	0.207	0.161	0.265	6.0	5	1013	4	20	14
19	C6	L	46.50%	0.637	-0.088	-0.110	-0.164	6.0	5	900	4	20	14
20	C6	R	82.36%	0.676	0.929	0.912	0.977	4.4	5	900	4	19	17
21	C6	M	66.82%	0.647	0.435	0.715	0.715	5.1	5	1013	4	19	17
22	C6	L	43.57%	0.766	-0.162	-0.184	-0.198	4.4	5	900	4	19	17
23	C6	M	53.41%	0.793	0.086	0.058	0.062	6.0	10	2025	5	24	14
24	C6	L	59.41%	0.741	0.238	0.435	0.372	5.8	10	1800	5	24	14
25	C6	R	51.51%	0.866	0.038	0.040	0.034	3.4	8	1440	5	19	11
26	C6	L	36.14%	0.798	-0.355	-0.540	-0.510	3.4	8	1440	5	19	11
27	C6	M	56.00%	0.131	0.151	0.241	0.241	5.6	8	1620	6	23	17
28	C6	M	70.15%	0.698	0.529	0.634	0.665	4.6	10	2025	6	25	16
29	C5	R	37.65%	0.075	-0.315	-0.062	-0.062	5.6	5	900	4	10	17
30	C5	R	52.63%	0.041	0.066	-0.005	0.085	4.6	8	1440	5	16	11
31	C5	R	55.70%	0.238	0.143	0.276	0.197	5.0	10	1800	5	20	17
32	C5	R	63.04%	0.464	0.333	0.397	0.397	4.8	6	1080	6	23	10
33	C5	M	62.97%	0.298	0.331	0.104	0.302	5.6	6	1215	6	17	22
34	C3	R	72.82%	0.840	0.607	0.490	0.468	4.8	5	900	4	21	23
35	C3	M	50.00%	0.613		1.095	1.195	5.2	5	1013	4	21	23
36	C3	L	60.91%	0.734	0.277	0.828	0.828	4.8	5	900	4	21	23
37	C3	R	64.37%	0.690	0.368	0.404	0.445	5.3	5	900	4	20	21
38	C3	M	66.35%	0.539	0.422	0.691	0.691	5.5	5	1013	4	20	21
39	C3	L	53.43%	0.772	0.086	0.262	0.262	5.3	5	900	4	20	21
40	C3	R	60.58%	0.751	0.268	0.419	0.426	4.8	5	900	5	21	21
41	C3	M	50.36%	0.760	0.009	0.019	0.019	5.1	5	1013	5	21	21
42	C3	L	55.26%	0.825	0.132	0.172	0.211	4.8	5	900	5	21	21
43	C3	L	47.22%	0.785	-0.070	-0.055	-0.091	3.6	5	900	5	23	17
44	C3	R	57.46%	0.716	0.188	0.290	0.275	4.8	5	900	6	25	17
45	C3	M	49.94%	0.708	-0.001	0.012	-0.002	4.8	5	1013	6	25	17
46	C3	L	54.19%	0.804	0.105	0.133	0.139	4.8	5	900	6	25	17
47	C3	R	58.24%	0.869	0.208	0.525	0.525	4.9	5	900	6	24	16
48	C1	R	45.22%	0.785	-0.120	-0.267	-0.267	4.9	5	900	4	18	19
49	C1	R	74.98%	0.083	0.674	0.946	0.946	5.4	5	900	5	13	13
50	C1	M	68.83%	0.425	0.491	0.538	0.538	5.6	5	1013	5	13	13
51	C1	L	65.92%	0.767	0.410	0.354	0.362	5.4	5	900	5	13	13
52	C1	M	86.47%	0.640	1.102	0.956	1.008	5.6	5	1013	5	25	25
53	C1	L	63.72%	0.655	0.351	0.376	0.405	5.4	5	900	5	25	25
54	C1	M	75.74%	0.742	0.698	0.446	0.657	5.8	10	2025	6	25	12

Apple CAI

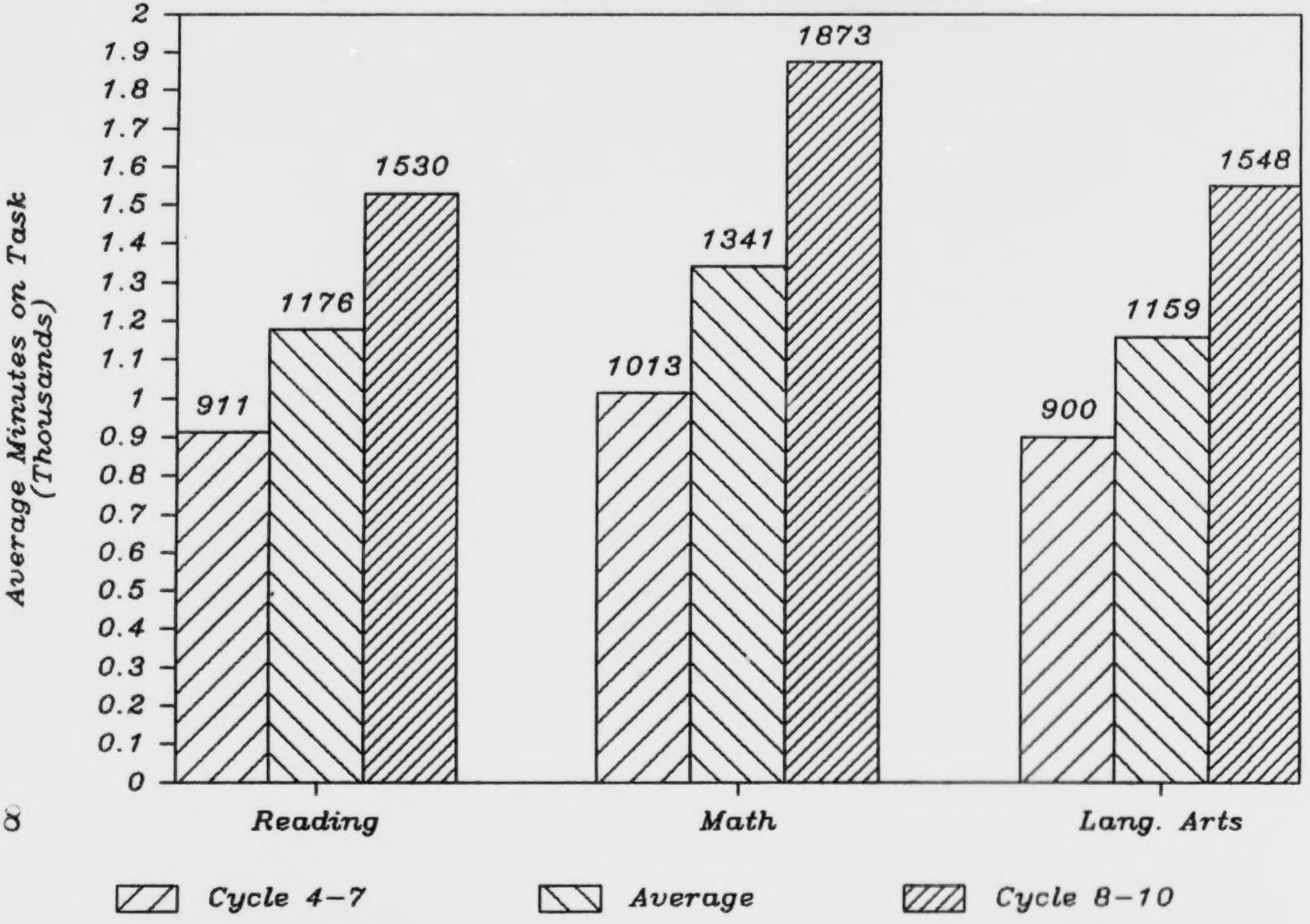
Index	School	Subject	ES%	D	ES	Unadj. Gain	Adj. Gain	Eval	Cycle	Time on Task	Grade	N exp.	N con.
55	C4	R	83.85%	0.657	0.988	0.723	0.912	5.5	10	1800	3	14	17
56	C4	M	69.57%	0.525	0.512	0.435	0.435	5.9	10	2025	3	14	17
57	C4	L	73.32%	0.633	0.623	0.950	0.798	5.5	10	1800	3	14	17
58	C4	R	58.36%	0.507	0.211	0.292	0.292	5.5	10	1800	3	14	18
59	C4	L	76.49%	0.774	0.722	0.811	0.746	5.5	10	1800	3	14	18
60	C4	R	90.86%	0.577	1.332	2.236	2.046	5.5	8	1440	4	14	18
61	C4	R	70.48%	0.710	0.538	1.214	0.855	5.5	8	1440	4	14	23
62	C4	L	41.68%	0.809	-0.210	-0.140	-0.248	5.5	8	1440	4	14	23
63	C4	R	60.68%	0.506	0.271	0.468	0.468	5.6	8	1440	4	13	18
64	C4	L	61.98%	0.623	0.305	0.309	0.405	5.6	8	1440	4	13	18
65	C4	R	72.76%	0.725	0.606	0.916	0.721	5.6	8	1440	5	20	24
66	C4	L	62.67%	0.698	0.323	0.584	0.510	5.6	8	1440	5	20	24
67	C4	R	51.44%	0.676	0.036	0.100	0.100	5.6	8	1440	5	20	21
68	C4	L	46.53%	0.700	-0.087	-0.156	-0.141	5.6	8	1440	5	20	22
69	C4	R	66.66%	0.765	0.431	0.709	0.512	5.7	8	1440	5	16	24
70	C4	L	62.55%	0.730	0.320	0.860	0.860	5.7	8	1440	5	16	24
71	C4	R	45.17%	0.772	-0.121	-0.155	-0.149	5.7	8	1440	5	16	24
72	C4	M	37.66%	0.664	-0.315	-0.275	-0.236	5.7	8	1620	5	16	24
73	C4	L	73.96%	0.725	0.642	0.418	0.284	5.7	8	1440	5	16	24
74	C4	R	76.66%	0.658	0.728	1.154	1.148	4.5	10	1800	6	24	25
75	C4	M	85.92%	0.690	1.077	1.183	1.184	4.8	10	2025	6	24	25
76	C4	L	72.24%	0.776	0.590	1.224	1.200	4.5	10	1800	6	24	25
77	C4	R	83.12%	0.645	0.959	1.458	1.281	4.5	10	1800	6	24	32
78	C4	M	77.46%	0.665	0.754	1.706	1.706	4.8	10	2025	6	24	32
79	C4	L	71.56%	0.716	0.570	1.625	1.491	4.5	10	1800	6	24	32

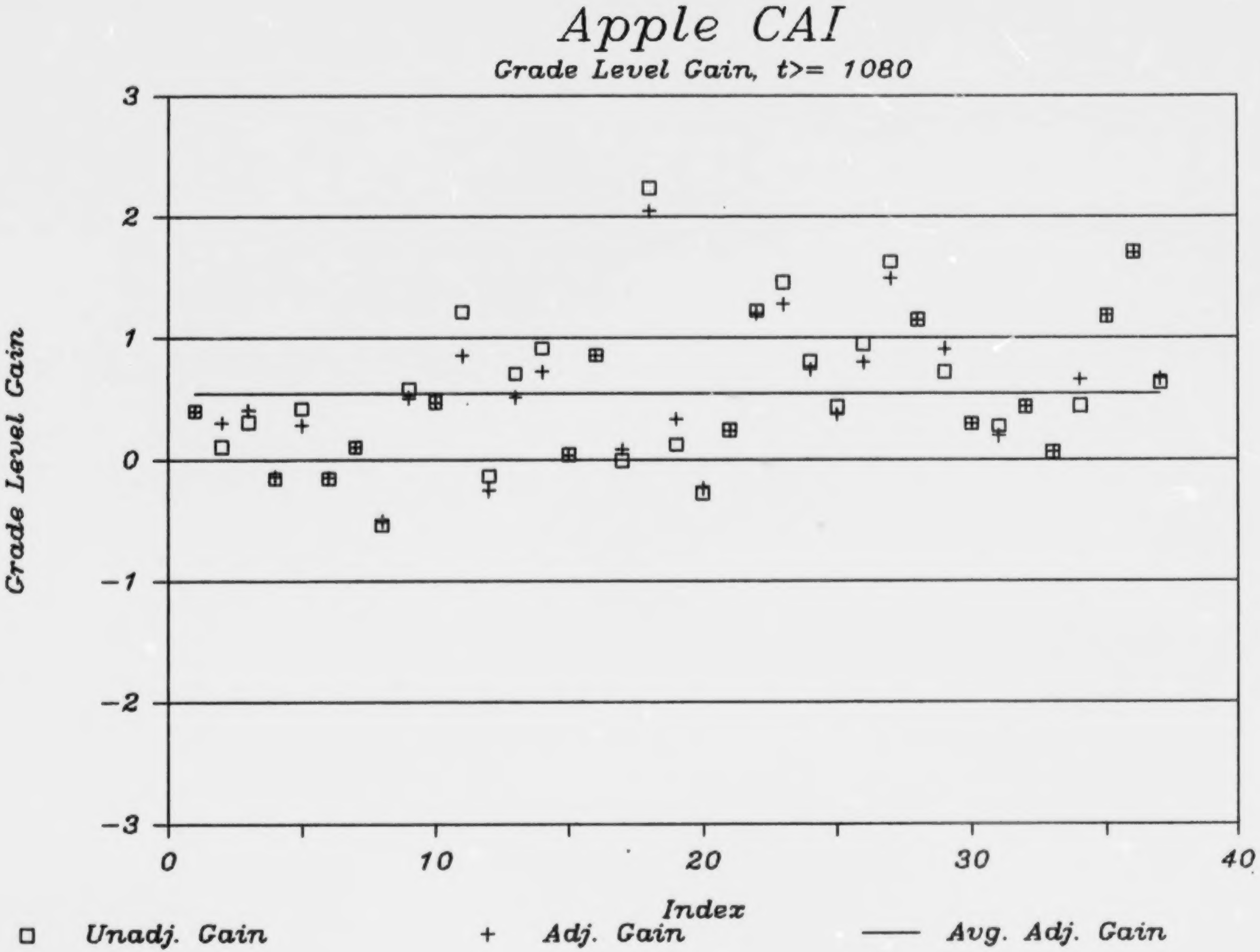
4th Grade Reading	0.451	0.674	0.616
4th Grade Math	0.352	0.557	0.640
4th Grade Language Arts	0.103	0.243	0.241
5th Grade Reading	0.103	0.133	0.119
5th Grade Math	0.144	0.125	0.141
5th Grade Language Arts	0.151	0.186	0.172
6th Grade Reading	0.206	0.266	0.240
6th Grade Math	0.201	0.223	0.264
6th Grade Language Arts	0.166	0.427	0.405
Total Reading	0.228	0.321	0.291
Total Math	0.214	0.275	0.318
Total Language Arts	0.142	0.269	0.257
Adj. Total Reading	0.437	0.655	0.593
Adj. Total Math	0.416	0.465	0.535
Adj. Total Language Arts	0.307	0.532	0.481

Adjusted totals refer to average based on classes
where time on task was >= 1080 minutes.

Apple CAI

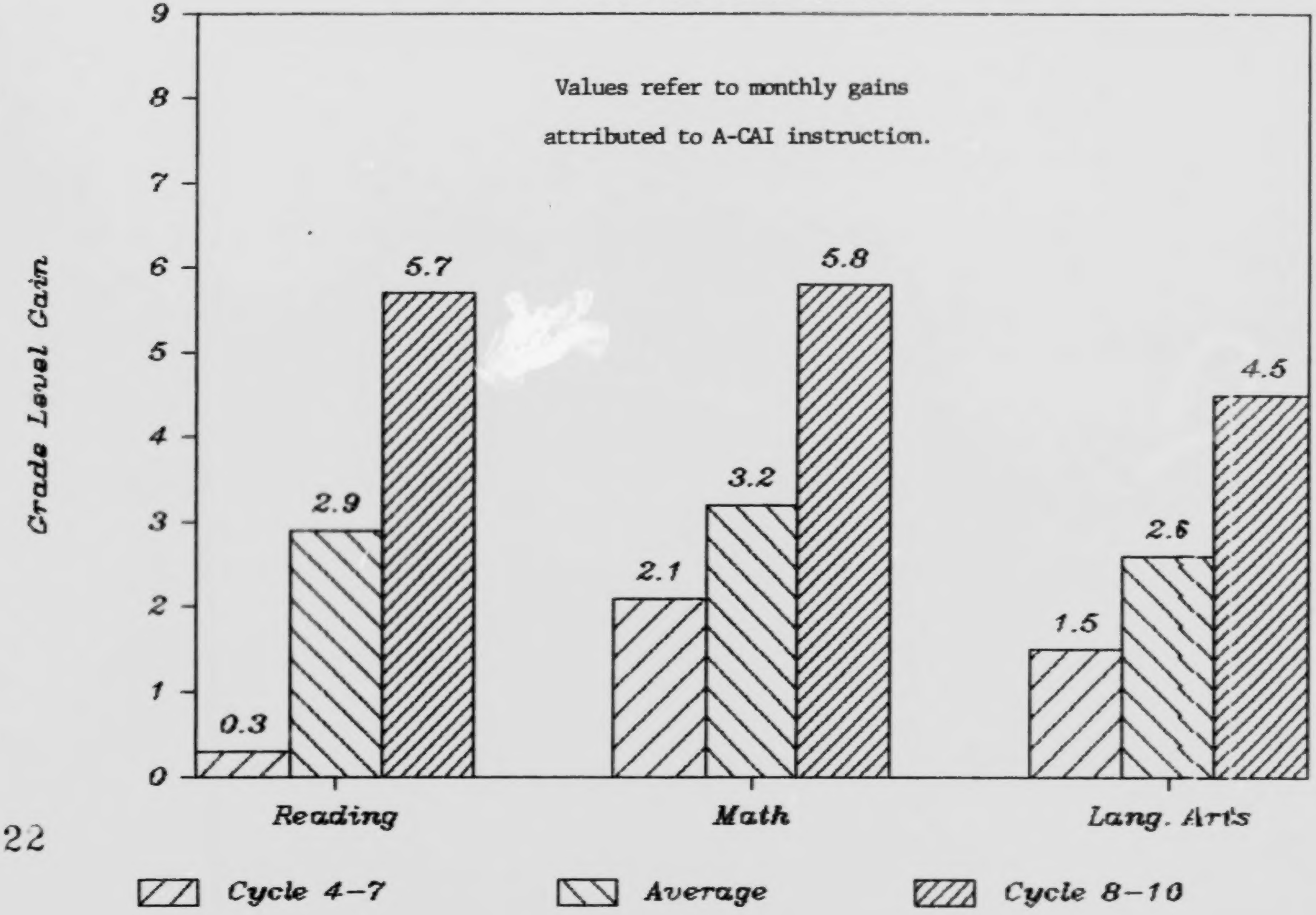
Time on Task Relation




Apple CAI
Grade Level Gain, t>= 1080
Grade Level Gain
3
2
1
0
−1
−2
−3
0
10
20
30
40
Index
□ Unadj. Gain
+ Adj. Gain
—— Avg. Adj. Gain

Apple CAI

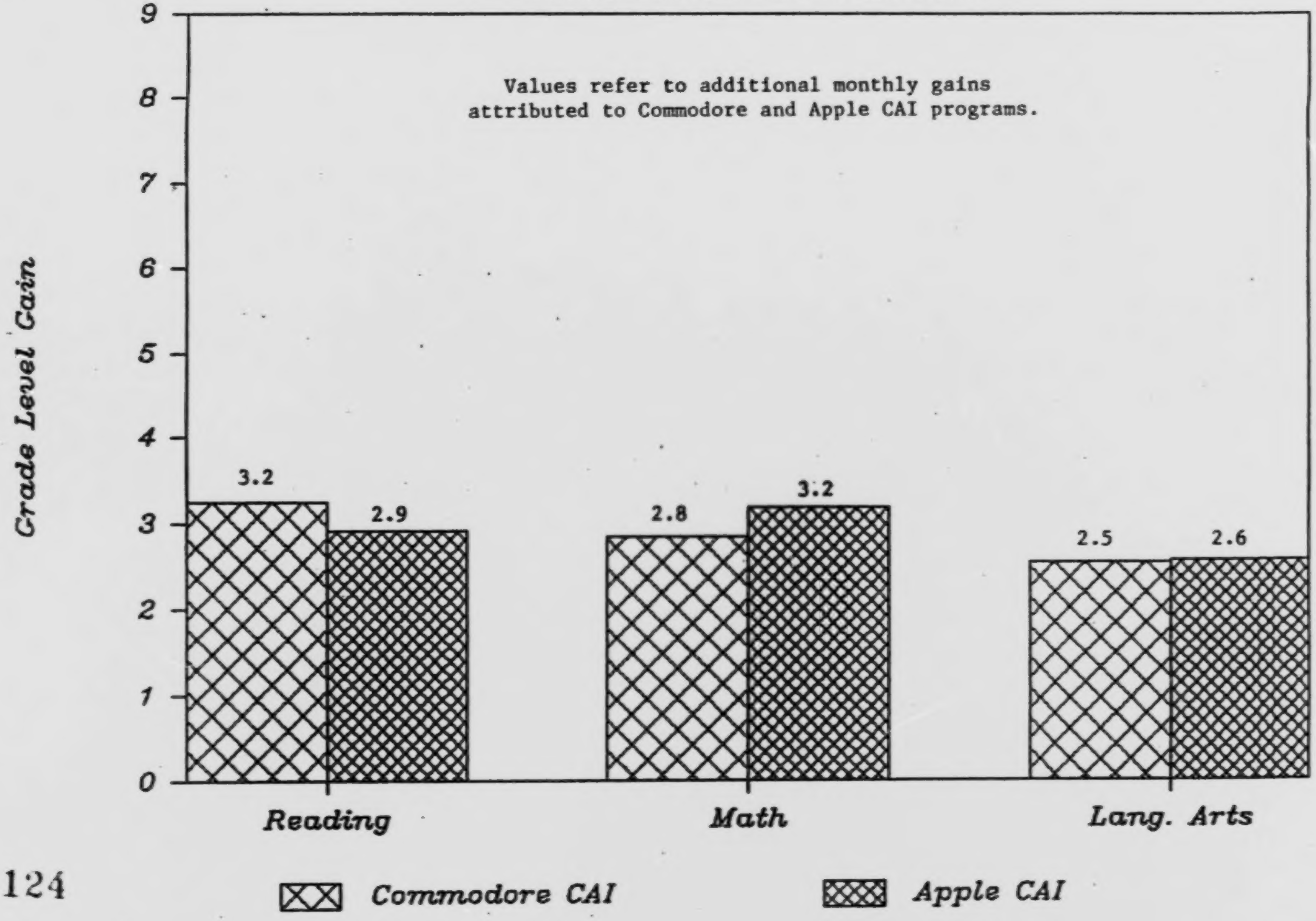
Time on Task Relation



Values refer to monthly gains attributed to A-CAI instruction.

Commodore CAI vs. Apple CAI

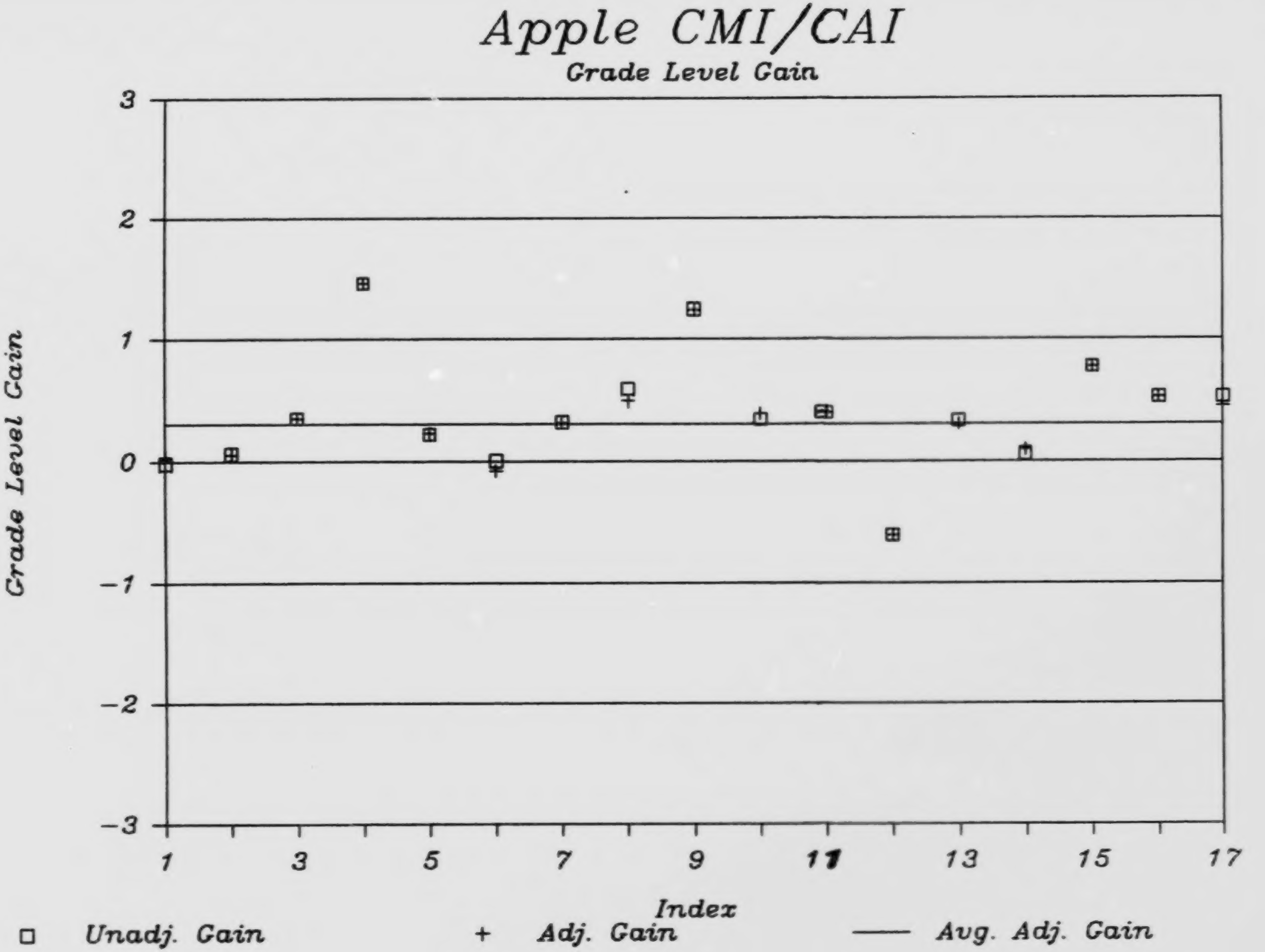
Grade Level Gain in Months



Values refer to additional monthly gains attributed to Commodore and Apple CAI programs.

Apple CMI/CAI

Index	School	Subject	ESZ	D	ES	Unadj. Gain	Adj. Gain	Eval	Cycle	Time On Task	Grade	N exp.	N con.
1	A5	M	50.46Z	0.634	0.012	-0.021	0.014	5.9	8	1200	4	29	24
2	A5	M	51.28Z	0.652	0.032	0.056	0.056	5.7	8	1200	5	20	24
3	A2	M	56.95Z	0.402	0.175	0.352	0.352	4.7	7	1050	4	21	22
4	A2	M	74.44Z	0.488	0.657	1.464	1.464	5.3	8	1200	5	20	13
5	B1	M	59.15Z	0.629	0.231	0.215	0.226	5.7	10	1500	5	39	23
6	B1	M	47.06Z	0.000	-0.074	-0.001	-0.081	4.5	10	1500	5	44	20
7	B1	M	58.20Z	0.715	0.207	0.316	0.316	5.9	10	1500	6	38	17
8	B1	M	65.15Z	0.682	0.389	0.590	0.494	4.9	10	1500	6	37	13
9	A3	M	79.50Z	0.400	0.824	1.247	1.247	5.4	8	1200	4	21	25
10	A3	M	62.49Z	0.685	0.319	0.339	0.390	5.5	8	1200	6	22	18
11	A3	M	54.70Z	0.613	0.118	0.397	0.397		10	1500	4	25	19
12	A3	M	41.96Z	0.740	-0.203	-0.607	-0.607		5	750	6	26	26
13	A4	M	63.72Z	0.713	0.351	0.334	0.303		8	1200	4	29	27
14	A4	M	53.15Z	0.723	0.079	0.057	0.092	5.2	10	1500	5	25	23
15	A4	M	71.94Z	0.664	0.581	0.776	0.775	5.3	8	1200	6	30	29
16	A4	M	56.39Z	0.555	0.161	0.526	0.526		10	1500	4	26	22
17	A4	M	50.00Z	0.565		0.523	0.452		10	1500	6	31	30
			4th Grade		0.273	0.472	0.473						
			5th Grade		0.185	0.358	0.351						
			6th Grade		0.259	0.323	0.303						
			Overall		0.241	0.386	0.377						

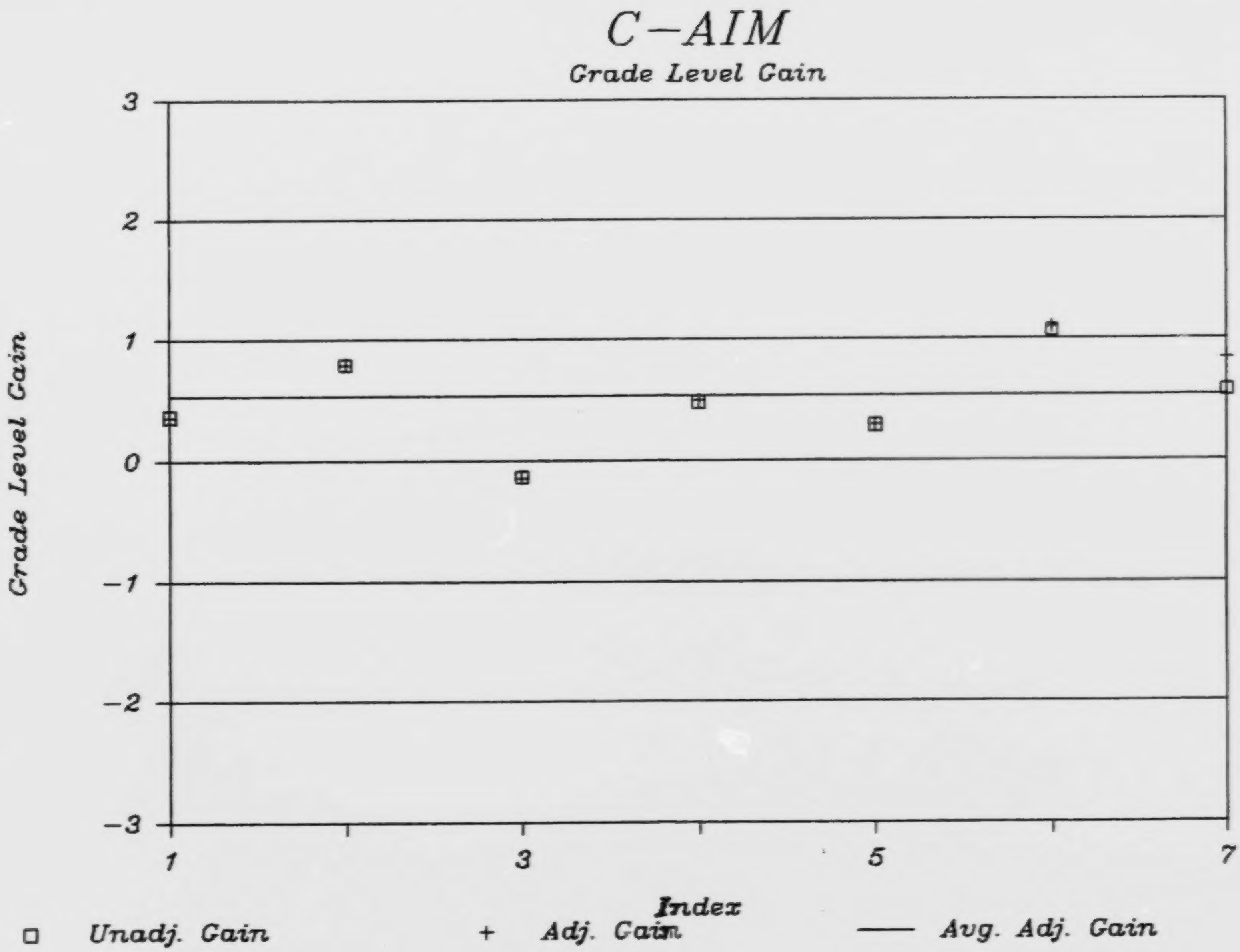

Apple CMI/CAI
Grade Level Gain
3
2
1
0
−1
−2
−3
Grade Level Gain
1
3
5
7
9
11
13
15
17
Index
□ Unadj. Gain
+ Adj. Gain
—— Avg. Adj. Gain

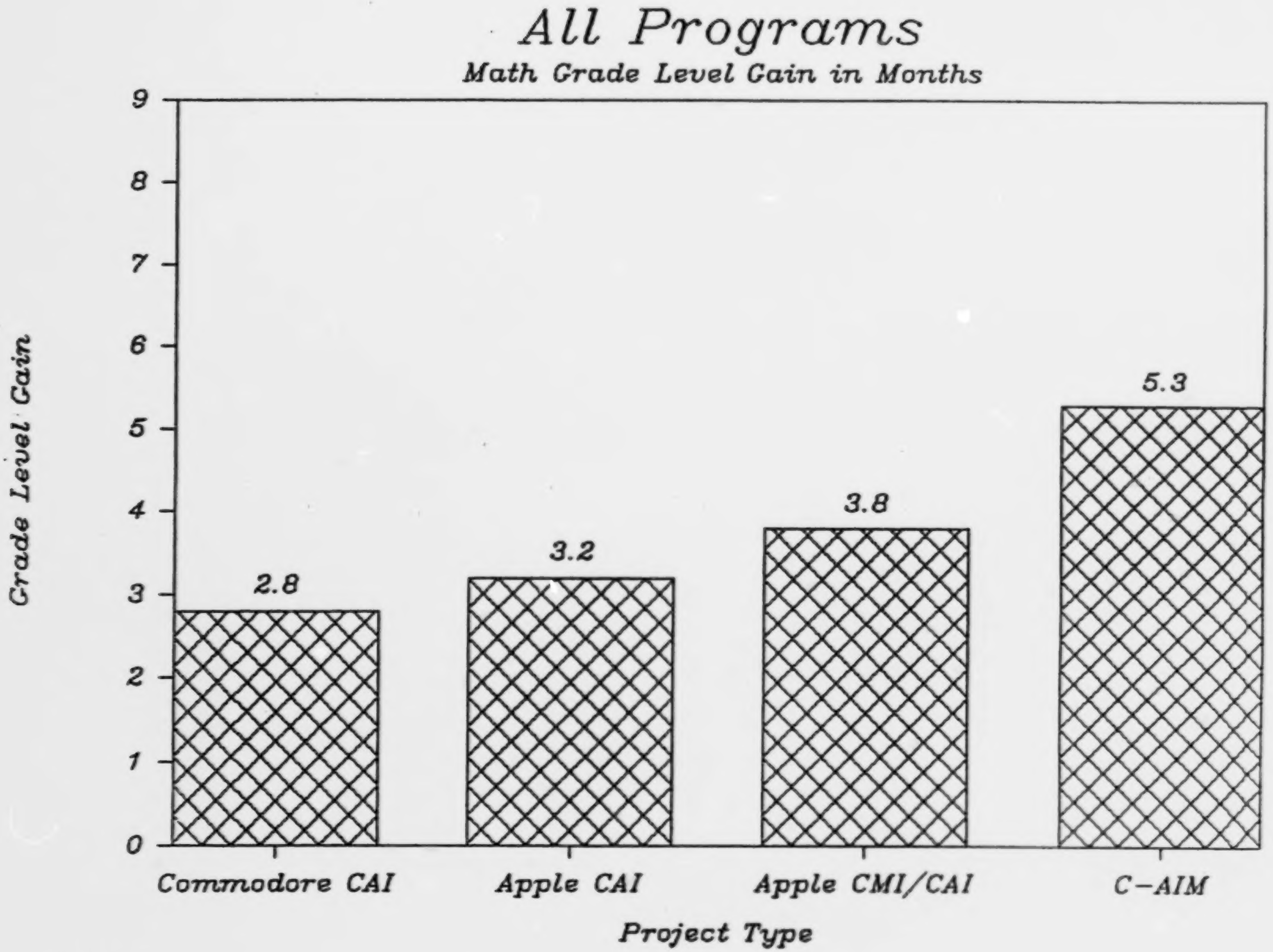
127

128

C-AIM

Index	School	Subject	ES%	D	ES	Unadj. Gain	Adj. Gain	Eval	Cycle	Time On Task	Grade	N exp.	N con.
1	H1	M	61.26%	0.467	0.286	0.364	0.364		5	1350	3	18	19
2	H1	M	75.40%	0.290	0.687	0.794	0.794		5	1350	3	21	22
3	H1	M	44.59%	0.647	-0.136	-0.138	-0.145		5	1350	4	26	18
4	H1	M	66.65%	0.567	0.430	0.481	0.492		5	1350	4	21	22
5	H1	M	57.38%	0.745	0.186	0.291	0.291		5	1350	5	25	24
6	H2	M	91.04%	0.458	1.343	1.069	1.098		5	1350	3	14	19
7	H2	M	80.45%	0.587	0.858	0.570	0.835		5	1350	5	22	15
8	H2	M	90.26%	0.516	1.297	1.817	1.987		5	1350	6	24	18
		3rd Grade Math			0.772	0.742	0.752						
		4th Grade Math			0.147	0.172	0.174						
		5th Grade Math			0.522	0.430	0.563						
		6th Grade Math			1.297	1.817	1.987						
		Overall			0.619	0.656	0.714						


C-AIM
Grade Level Gain
3
2
1
0
−1
−2
−3
Grade Level Gain
1
3
5
7
Index
□ Unadj. Gain
+ Adj. Gain
—— Avg. Adj. Gain


All Programs
Math Grade Level Gain in Months
Grade Level Gain
9
8
7
6
5
4
3
2
1
0
2.8
3.2
3.8
5.3
Commodore CAI
Apple CAI
Apple CMI/CAI
C-AIM
Project Type

Time on Task -- Apple CAI
Average Grade Level Gain

Subject

	Reading		Math		Language Arts	
	N	Avg.	N	Avg.	N	Avg.
4-5-6-7 Cycle	17	0.030	12	0.210	15	0.146
Overall Average	29	0.291	19	0.319	26	0.257
8-9-10 Cycle	12	0.567	7	0.588	11	0.451

Time on Task -- Apple CAI
Average Time on Task
(minutes per year)

Subject

	Reading		Math		Language Arts	
	N	Avg.	N	Avg.	N	Avg.
4-5-6-7 Cycle	17	911	12	1013	15	900
Overall Average	29	1176	19	1341	26	1159
8-9-10 Cycle	12	1530	7	1873	11	1548

Time on Task -- Commodore CAI
Average Grade Level Gain

Subject

	Reading		Math		Language Arts	
	N	Avg.	N	Avg.	N	Avg.
4-5-6-7 Cycle	19	0.252	20	0.138	18	0.149
Overall Average	35	0.326	37	0.284	36	0.254
8-9-10 Cycle	16	0.413	17	0.456	18	0.340

Time on Task -- Commodore CAI
Average Time on Task
(minutes per year)

Subject

	Reading		Math		Language Arts	
	N	Avg.	N	Avg.	N	Avg.
4-5-6-7 Cycle	19	938	20	1114	18	930
Overall Average	35	1209	37	1451	36	1235
8-9-10 Cycle	16	1530	17	1834	18	1540

Commodore CAI
Unadjusted Mean Gains

	Grade	Experimental	Control	Difference
Reading	4	1.31	.92	.39
Math	4	.91	.82	.09
Lang. Arts	4	1.12	.91	.21
Reading	5	1.63	1.34	.29
Math	5	1.56	1.10	.46
Lang. Arts	5	1.52	1.05	.47
Reading	6	1.20	1.05	.15
Math	6	1.62	1.23	.39
Lang. Arts	6	1.19	1.16	.03
Reading	overall	1.37	1.08	.29
Math	overall	1.32	1.04	.28
Lang. Arts	overall	1.26	1.02	.24

Apple CAI
Unadjusted Class Mean Gains

	Grade	Experimental	Control	Difference
Reading	4	1.76	1.09	.67
Math	4	1.68	1.12	.56
Lang. Arts	4	1.13	.88	.24
Reading	5	1.25	1.12	.13
Math	5	1.20	1.07	.13
Lang. Arts	5	1.30	1.11	.19
Reading	6	1.21	.94	.27
Math	6	1.65	1.43	.22
Lang. Arts	6	1.53	1.10	.43
Reading	overall	1.39	1.07	.32
Math	overall	1.53	1.25	.28
Lang. Arts	overall	1.32	1.05	.27

Analysis of the mathematics data related to the Commodore CAI and Apple CAI programs was done with respect to mean gains by classes with a pre-test class average below grade level, at grade level and above grade level. A class was defined to be below grade level if the class average was .4 or more below the classes' regular grade level. A class was defined to be above grade level if the class average was .4 or more above the classes' regular grade level. A class was defined as at grade level if it was neither above or below grade level. Data on 37 Commodore CAI classes and 21 Apple CAI classes are presented on the next page.

Mathematics Post-test
Unadjusted Mean Gains

Class Average	N= 37 Commodore CAI	N= 21 Apple CAI
Pretest mean/classes below grade level	1.38	1.43
Pretest mean/classes at grade level	1.34	1.41
Pretest mean/classes above grade level	1.30	1.34
Overall average	1.32	1.41

The progress of 647 students in the 5th grade reading Apple and Commodore CAI programs and 526 students in the 6th grade mathematics Apple and Commodore CAI programs was monitored to determine the percentage of students that moved from below grade level to grade level or above. A shift of 7% of the students was observed in 6th grade mathematics and 6% in 5th grade reading.

All Classes
Adjusted Gain, Experimental (+) vs. Control (-)

Adj. Gain	Apple CAI	Commodore CAI	CMI-CAI	C-AIM	Total
+	50	79	15	7	151
-	24	29	2	1	56
%	67.6	73.1	88.2	87.5	72.9

If +, - gains are binomially distributed with $p=0.5$, $q=0.5$ and $N=207$; then, the 99% confidence interval is $0.411 \leq p \leq 0.589$. It follows that the 99% confidence interval for the number of classes with positive gains is $85 \leq N(+) \leq 122$. In this study, $p=0.729$ and $N(+)=151$.

Apple CAI
74 Classes
Adjusted Gain, Experimental (+) vs. Control (-)

	Reading			Math			Lang. Arts		
	+	-	%	+	-	%	+	-	%
4th Grade	6	2	75.0%	5	0	100.0%	4	3	57.1%
5th Grade	8	5	61.5%	4	2	66.7%	7	4	63.6%
6th Grade	5	2	71.4%	6	4	60.0%	5	2	71.4%
Total	19	9	67.9%	15	6	71.4%	16	9	64.0%

Commodore CAI
108 Classes
Adjusted Gain, Experimental (+) vs. Control (-)

	Reading			Math			Lang. Arts		
	+	-	%	+	-	%	+	-	%
4th Grade	12	2	85.7%	10	5	66.7%	11	4	73.3%
5th Grade	10	1	90.9%	6	1	85.7%	9	2	81.8%
6th Grade	5	5	50.0%	11	4	73.3%	5	5	50.0%
Total	27	8	77.1%	27	10	73.0%	25	11	69.4%

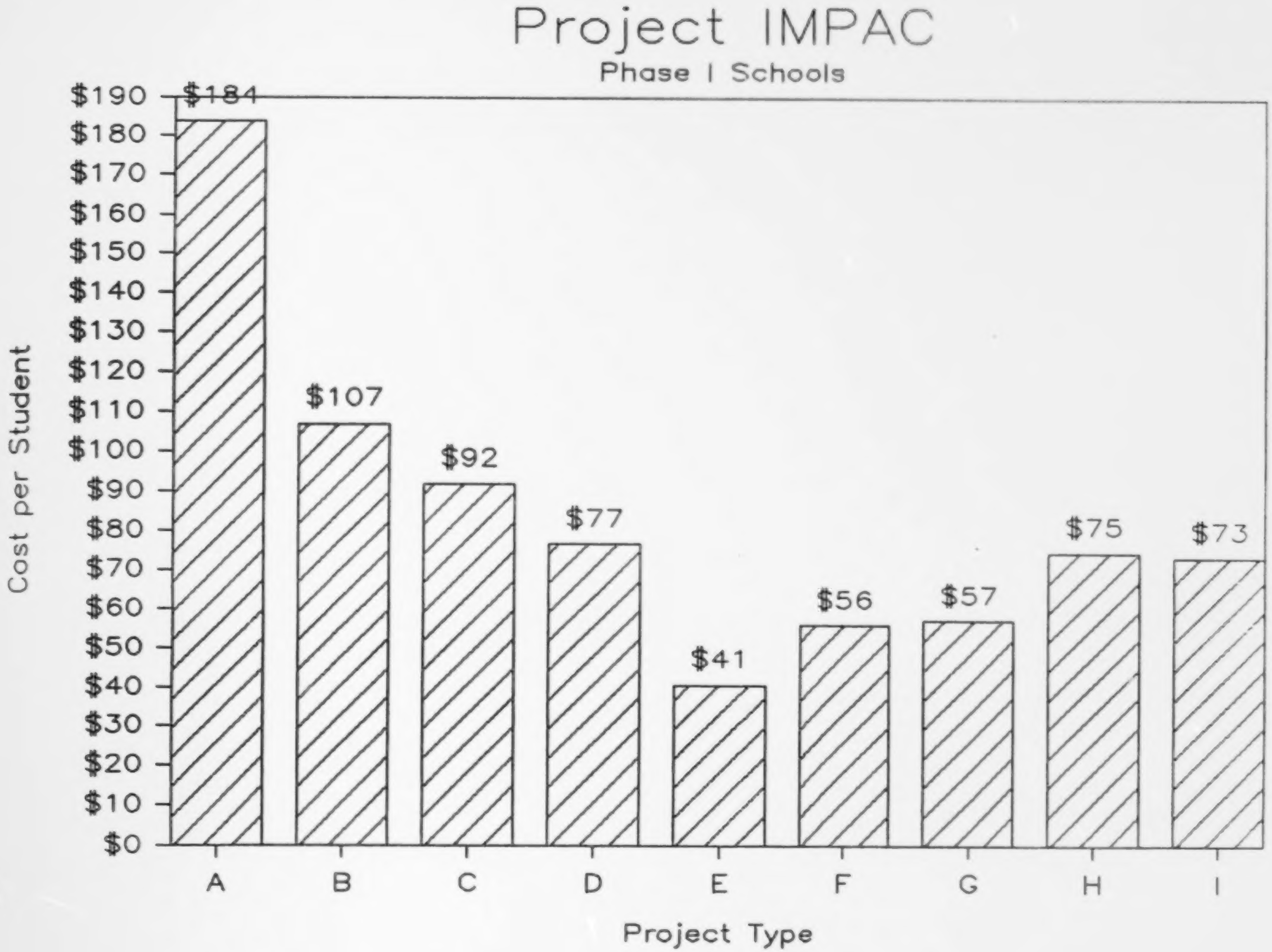
Classification of Effect Size (ES)
All Programs and Classes
Time on Task ≥ 1080 Minutes
N=158

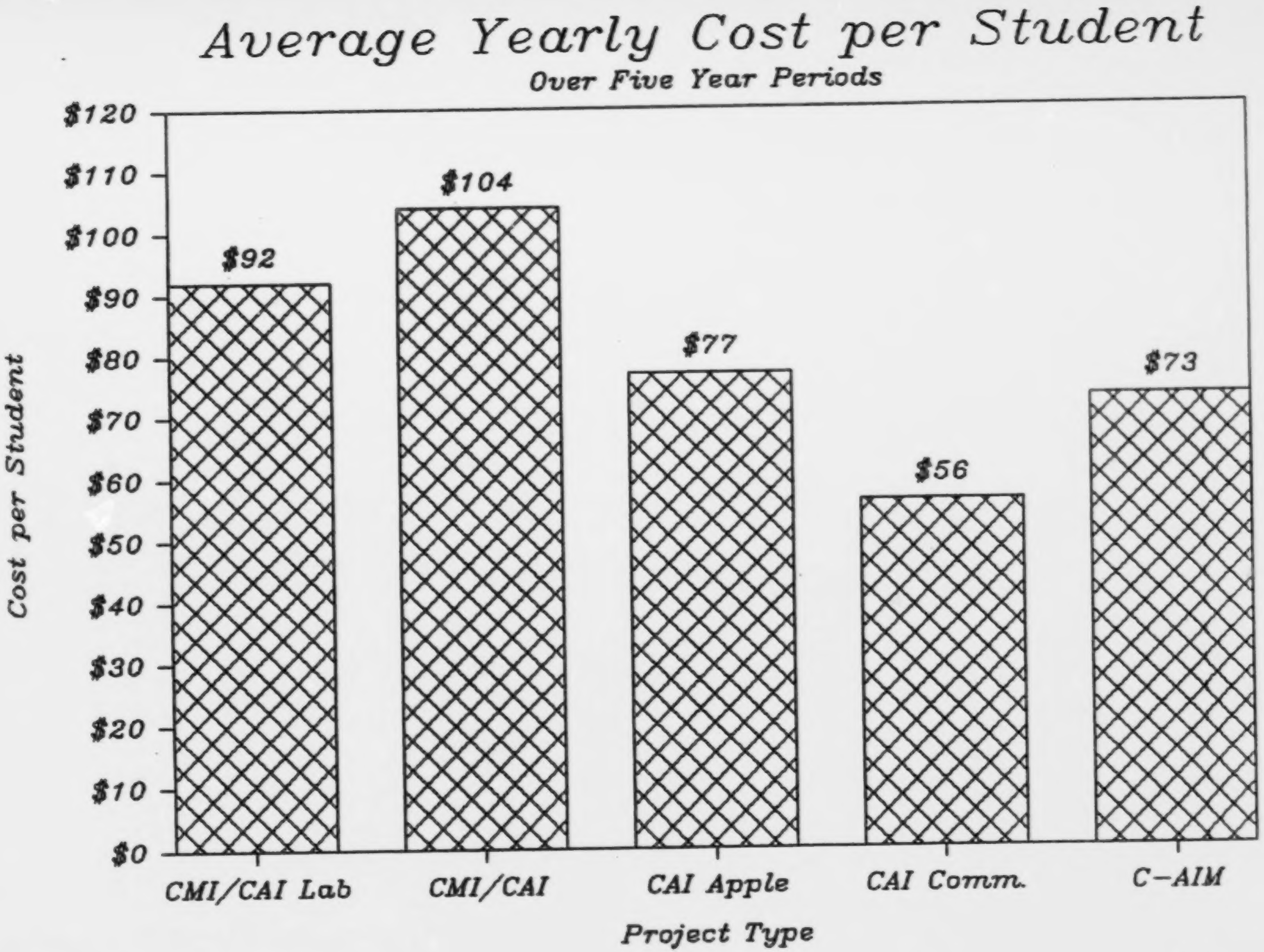
	Negatives ES below 0.0	Negligible ES 0.0 to .19	Small ES .20 to .49	Medium ES .50 to .79	Large ES .80 and up
Frequency	29	29	53	31	16
Percentage	18%	18%	34%	20%	10%

School District	No. of Sections	No. of Students	Initial Cost Hardware	 Software	 Misc.	Four Year Cost	Total Cost	Cost Per Student	Project Type
CMI-CAI Apple Classroom Network									
School A1	3	405	$36,492.76	$14,385.00	$3,900.00	$19,496.00	$74,273.76	$183.39	A
School A2	3	405	$36,905.65	$14,385.00	$7,442.76	$19,496.00	$78,229.41	$193.16	A
School A3	3	365	$36,492.76	$14,385.00	$1,000.00	$19,496.00	$71,373.76	$195.54	A
School A4	3	450	$36,492.76	$14,385.00	$4,356.34	$19,496.00	$74,730.10	$166.07	A
CMI-CAI Apple Lab Network									
School A5	6	730	$40,026.51	$14,385.00	$3,999.65	$19,496.00	$77,907.16	$106.72	B
School B1	10	1250	$45,461.38	$14,385.00	$6,280.37	$48,618.65	$114,745.40	$91.80	C
CAI - Apple									
School D1	6	735	$27,095.85	$10,184.53	$1,000.00	$7,651.00	$45,931.38	$62.49	D
School C5	6	730	$34,593.30	$10,096.88	$1,000.00	$7,651.00	$53,341.18	$73.07	D
School C3	6	730	$34,593.30	$13,345.64	$1,000.00	$7,651.00	$56,589.94	$77.52	D
School C2	12	1395	$34,593.30	$13,345.64	$1,000.00	$7,651.00	$56,589.94	$40.57	E
School C4	6	570	$34,593.30	$10,096.88	$1,000.00	$7,651.00	$53,341.18	$93.58	D
School C6	6	700	$34,593.30	$10,096.88	$1,238.06	$7,651.00	$53,579.24	$76.54	D
School C1	6	710	$34,593.30	$13,345.64	$1,031.50	$7,651.00	$56,621.44	$79.75	D
CAI Commodore									
School G1	7	935	$25,656.30	$16,454.63	$1,391.00	$7,651.00	$51,152.93	$54.71	G
School E4	5	475	$12,817.25	$7,923.27	$1,072.70	$7,651.00	$29,464.22	$62.03	G
School E2	6	595	$19,671.96	$9,323.66	$1,178.43	$7,651.00	$37,825.05	$63.57	F
School E3	6	665	$19,223.82	$9,422.99	$1,144.22	$7,651.00	$37,442.03	$56.30	F
School E5	6	740	$19,223.82	$9,323.66	$1,038.61	$7,651.00	$37,237.09	$50.32	F
School E1	6	690	$19,223.82	$9,840.86	$1,164.88	$7,651.00	$37,880.56	$54.90	F
CAI Commodore Lab									
School F1	6	540	$19,484.10	$7,340.09	$5,835.25	$7,651.00	$40,310.44	$74.65	H
CAI/C-AIM Commodore									
School H1	6	740	$27,840.00	$12,842.00	$1,000.00	$8,501.00	$50,183.00	$67.81	I
School H2	6	630	$27,840.00	$12,842.00	$1,076.47	$8,501.00	$50,259.47	$79.78	I

Summary

A. CMI-CAI Apple 3 teachers - Self Contained	$183.76
B. CMI-CAI Apple 3 teachers - Departmentalized	$106.72
C. CMI-CAI Apple Lab	$91.80
D. Apple-CAI - Self Contained	$76.50
E. Apple-CAI - Departmentalized	$40.57
F. Commodore-CAI - Self Contained	$55.91
G. Commodore-CAI - Departmentalized	$57.18
H. CAI Commodore Lab	$74.65
I. CAI-C-AIM Commodore	$73.32


Project IMPAC
Phase I Schools
Cost per Student
$190
$180
$170
$160
$150
$140
$130
$120
$110
$100
$90
$80
$70
$60
$50
$40
$30
$20
$10
$0
$184
$107
$92
$77
$41
$56
$57
$75
$73
A
B
C
D
E
F
G
H
I
Project Type



Average Yearly Cost per Student

Over Five Year Periods

COURSEWARE USED IN IMPAC PROJECT SCHOOLS

Apple CAI Programs: Corning, Mammoth Spring and South Mississippi County

Math:

Title	Publishing Company
Elementary Classroom Learning System	Sterling Swift
San Diego Math	San Diego School District
Math Strategies - Estimation	Science Research Associates
Adding Fractions	Microcomputer Workshops
1-2-3 Digit Multiplication	Microcomputer Workshops
Multiplying Fractions	Microcomputer Workshops
Long Division	Microcomputer Workshops
Fast Facts	EduSoft

Reading:

Title	Publishing Company
Processing Power	I/CT Inst. Communications Tech
Cloze Plus	I/CT Inst. Communications Tech
Capitalization - Test & Practice	Hartley Courseware
Zaner Bloser Spellware	Zaner Bloser

Apple CAI Programs: El Dorado, Gurdon, Texarkana and Benton

Math:

Title	Publishing Company
SRA Math levels B, C & D	Science Research Associates
San Diego Math	San Diego School District
Math Strategies - Estimation	Science Research Associates
Adding Fractions	Microcomputer Workshops
1-2-3 Digit Multiplication	Microcomputer Workshops
Multiplying Fractions	Microcomputer Workshops
Long Division	Microcomputer Workshops
Fast Facts	EduSoft

Reading:

Title	Publishing Company
Skill Corp Reading	Skill Corp.
Mastering the Parts of Speech	SVE (Society for Visual Ed.)
Capitalization - Test & Practice	Hartley Courseware
Zaner Bloser Spellware	Zaner Bloser

Commodore CAI Program: Waldron

Math:

Title	Publishing Company
Fundamentals of Math	Sterling Swift
Pet Professor	Cow Bay Computing
Public Domain Math	
Prime Numbers and Factors	Micro-Ed
Fraction Concepts	Micro-Ed
Fraction Operations	Micro-Ed
Money	Micro-Ed
Measurement	Micro-Ed
Decimals	Micro-Ed

Reading:

Title	Publishing Company
Diascriptive Reading II	Educational Activities
Public Domain Reading & Language Arts	
Basic Grammar One	Micro-Ed
Basic Grammar Two	Micro-Ed
Reference Skills	Micro-Ed
Zaner Bloser Spellware	Zaner Bloser
Bank Street Writer	Scholastic

Commodore CAI Programs: Stuttgart, Gould, Hot Springs and Marshall

Math:

Title	Publishing Company
Fundamentals of Math	Sterling Swift
Pet Professor	Cow Bay Computing
Public Domain Math	
Prime Numbers and Factors	Micro-Ed
Fraction Concepts	Micro-Ed
Fraction Operations	Micro-Ed
Money	Micro-Ed
Measurement	Micro-Ed
Decimals	Micro-Ed

Reading:

Title	Publishing Company
Diascriptive Reading II	Educational Activities
Public Domain Reading & Language Arts	
Basic Grammar One	Micro-Ed
Basic Grammar Two	Micro-Ed
Reference Skills	Micro-Ed
Zaner Bloser Spellware	Zaner Bloser

Commodore CAI Program: Conway

Math:

Title	Publishing Company
Fundamentals of Math	Sterling Swift
Pet Professor	Cow Bay Computing
Public Domain Math	
Prime Numbers and Factors	Micro-Ed
Fraction Concepts	Micro-Ed
Fraction Operations	Micro-Ed
Money	Micro-Ed
Measurement	Micro-Ed
Decimals	Micro-Ed

Apple CMI-CAI Programs: Fayetteville, Fort Smith, Monticello, Pine Bluff, Pulaski County and Vilonia

Math:

Title	Publishing Company
Mathware	Essertier Software Corporation
San Diego Math	San Diego School District

ARKANSAS MICROCOMPUTER SURVEY

Introduction

For the fourth year the Arkansas Department of Education has conducted a microcomputer survey of school districts. Ninety-six (96) percent of the school districts reported.[55] Only 16 districts failed to return the survey form. It should be noted that a time period of fifteen (15) months has passed since the last school survey was completed. Areas covered in this section are:

1. Statistics on the number of microcomputers owned by school districts by brand.

2. Statistics on the location of microcomputers within school districts by instructional level (elementary, junior high and high school)

3. Statistics on the instructional use of microcomputers within school districts by instructional level.

This survey indicates that as of December, 1984, there are 9405 microcomputers in 342 school districts. Eighty-six percent of the brands were produced by Commodore (43.2%), Radio Shack (27.2%) and Apple (15.6%). This was expected since at least 90% of the educational software available will run on microcomputers produced by these companies.

Seventy-five percent (75%) of the school districts using microcomputers are using them at the elementary school level, thirty-seven percent (37%) at the junior high school level and ninety percent (90%) at the high school level.

The average number of microcomputers per district is twenty-seven (27). However, only ninety-one (91) districts have twenty-seven (27) or more microcomputers. One-half of the school districts own 14 or fewer microcomputers. The ratio of students per microcomputers is 46 to 1.

Number and Percent of Microcomputers by Brand

The data below indicates that 5,167 microcomputers were added between October 1983 and December 1984. However, 493 of these microcomputers were purchased for use in 22 IMPAC pilot projects.

Table I and the explanations below provide detailed information on the number of microcomputers by brand that are being used in Arkansas school districts.

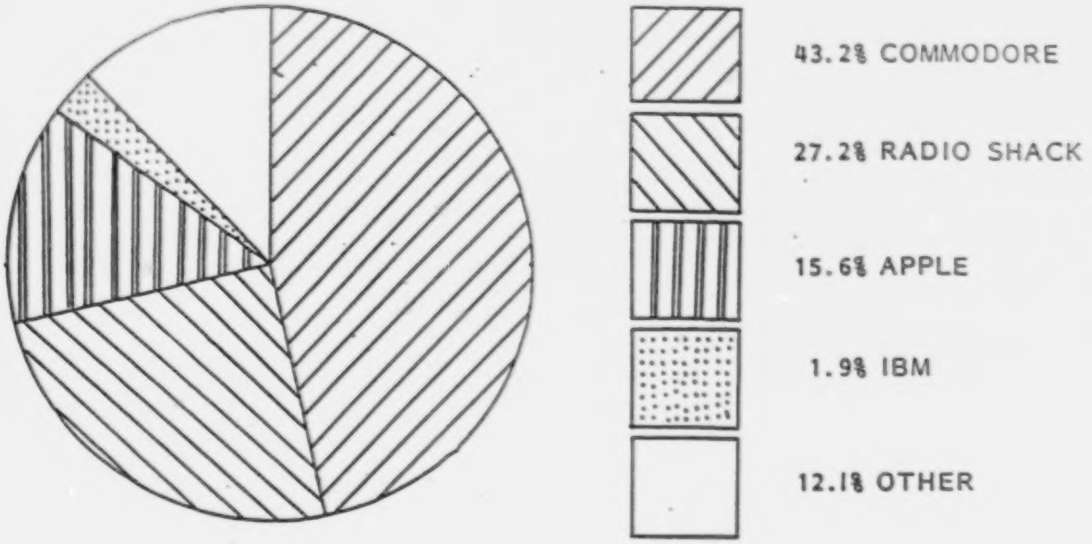
Table 1

BRAND	JAN '83	OCT '83	%TOTAL OCT 83	DEC '84	%TOTAL DEC 84	GAIN/ LOSS
Commodore	881	2013	47.6	4058	43.2	-4.4%
Radio Shack	527	1357	32.1	2562	27.2	-4.9%
Apple	92	416	9.8	1465	15.6	+5.8%
Texas Instruments	59	257	6.1	616	6.6	+ .5%
Franklin	-0-	144	3.4	481	5.1	+1.7%
IBM	2	36	.8	181	1.9	+1.1%
Atari	-0-	2	0	13	.1	+ .1%
Other	8	13	.2	29	.3	+ .1%
	1569	4238	100.0	9405	100.0	
Student/Computer ratio in Arkansas Public Schools:	275/1	102/1		46/1		

1. 2100 of the 4058 Commodore microcomputers are the Commodore 64 model.
2. 1523 of the 2045 Commodores purchased in 1984 were Commodore 64's.
3. 90.2% of the 4,238 microcomputers in October 1983 were of the four major brands.*
4. 87.9% of the 9,405 microcomputers on December 1984 were of the four major brands.*

The normal increase based on previous growth in the number of microcomputers from January 1983 provides an estimate of 8,693 for the total number of microcomputers in school districts by December 1984. However, 493 microcomputers were purchased for IMPAC projects during 1984. Therefore, the staff's estimate of the number of microcomputers in schools as of December 1984 was 9,186. This projected increase of 116.8% compares to the 121.9% actual increase.

* The four major brands nationally in education are Apple, Radio Shack, Commodore and IBM.



MICROCOMPUTER PERCENTAGE BY BRAND NAME

Commodore-Apple-Radio Shack Microcomputers by Model

Table 2 provides a more detailed breakdown on the types of Commodore, Apple and Radio Shack computers being used in school districts.

Table 2

Commodore - Apple - Radio Shack
by Model

Commodore PET	1873	Radio Shack Model IV	1255
Vic 20	85	Radio Shack Model III	678
Commodore 64	2100	Color Computer/Models I & II	629
Total	4058	Total	2562

Apple IIe	1217
Apple II+	115
Apple II	109
Apple IIc	24
Total	1465

Number of School Districts with Microcomputers by Organizational Units

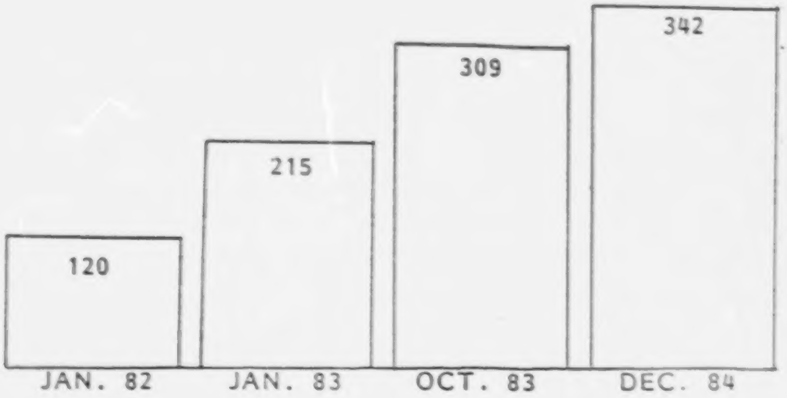
Table 3, Table 4 and Table 5 provide a summary of the number of school districts owning microcomputers and the number of school districts presently owning and using microcomputers at various grade levels.

Table 3

Comparison of Number of School Districts Owning Microcomputers
January 1982, January 1983, October 1983, December 1984

	Jan. 82	Jan. 83	Oct. 83	Dec. 84
Districts owning microcomputers	120	215	309	342
Districts not owning microcomputers	235	139	42	9
Districts not reporting	15	16	16	16

93.2% of the school districts in Arkansas own one or more microcomputers.



DISTRICTS OWNING MICROCOMPUTERS

Table 4

Number of School Districts with Microcomputers in Elementary, Junior High and High School December 1984

Districts with Microcomputers in:	No. of Districts	%
Elementary, Junior High and High School	112	30.5%
Elementary and Junior High only	5	1.4%
Elementary and Senior High only	154	41.9%
Junior and Senior High only	16	4.4%
Elementary School only	6	1.6%
Junior High School only	2	0.5%
High School only	47	12.8%
No microcomputers in district	9	2.5%
Districts not reporting	16	4.4%
	367	100.0

NOTE: Percents are based on 367 school districts.

Three hundred forty-two (342) school districts have at least one instructional program using microcomputers in at least one of these grade level categories. The following table provides a more detailed breakdown of the information in the above table. The percentages are based on 367 school districts.

Table 5

School District Ownership of Microcomputers by Organizational Units

Grade Level	Number of Districts Owning One or More Microcomputers	-%-
Elementary	277	75.5
Junior High	135	36.8
High School	329	89.7

Instructional Applications by Grade Level Categories

Table 6 provides detailed information about the instructional use of microcomputers in Arkansas school districts. The Arkansas Commission on Microcomputer Instruction has encouraged school districts to utilize microcomputers in grades 3-8 for basic skills instruction.[56] The Commission has not encouraged computer literacy activities in the elementary school except through the regular use of microcomputers as an instructional tool. The survey clearly indicates that school districts are following the guidelines developed by the Commission.

Table 7 has been developed to provide an analysis of the data in Table 6 so that it is easy to determine the major instructional uses of microcomputers in Arkansas classrooms.

Table 6
Instructional Applications by Grade Level Categories

Elementary

Program Type	Number of Inst. Prog.	Number of Students	Number of Teachers
*Computer Assisted Instruction	292	75,539	2,742
Computer Managed Instruction	30	8,420	256
Computer Literacy and Programming	25	4,483	168

Junior High or Middle School

Program Type	Number of Inst. Prog.	Number of Students	Number of Teachers
*Computer Assisted Insruction	171	29,728	785
Computer Managed Instruction	10	2,160	41
Computer Literacy and Programming	64	7,932	119

The following table indicates that schools are predominately using microcomputers as an instructional aid at the elementary and junior high level, and in business education and programming at the high school level.

Table 7
Instructional Applications by Program Type,
Grade Level Categories and Percent of Students Involved
in a Particular Program Type

Elementary

Program Type	Percent
Computer Assisted and Managed Instruction	95%
Computer Literacy and Programming	5%

Junior High or Middle School

Program Type	Percent
Computer Assisted and Managed Instruction	80%
Computer Literacy and Programming	20%

IMPLICATIONS OF RESEARCH FOR PROGRAM IMPLEMENTATION

Administrators need to develop six (6) year plans for the implementation of technology related programs which include the use of microcomputers. State policies should be developed that address common needs of school districts, regional resource centers, university and college education departments and the State Department of Education. Such needs in Arkansas include a systematic approach to the monitoring of student progress in basic skills, the use of technology to address the needs of small school districts in the teaching of advanced science and mathematics courses and enhancing foreign language and college preparatory English course offerings. The process of making decisions six (6) years at a time with yearly evaluations provides a systematic way to take advantage of current technology and plan ahead for program continuity or adding new programs resulting from advancing technology.

School district policies should also address the section of the plan which encourages the use of microcomputers in grades 3-8 for supplementary instruction in at least two of the five basic skills areas - mathematics, reading, language arts, science and social studies. Other components of computer-based instruction should include the offering of an introductory computer science course in grades 9 or 10, certain aspects of business education and accounting courses, availability of word processing for teachers and students especially in advanced English and social studies classes, and advanced programming centered around application software and the structured language Pascal.

Teachers should be directly in control of the CAI, CMI-CAI applications and help determine the specifications of the CMI software used to monitor basic skills progress. In-service training based on the IMPAC Level I, Level II and Level III guidelines should coincide with implementation activities. Assessment of vendor support and identification of appropriate software should precede the actual purchase of hardware. The hardware decision should be considered separately for grades 3-8 and 9-12 since the applications require hardware that meet two separate sets of criteria with minimal overlap. The hardware purchase should be a five (5) year decision based on assurances that maintenance support will be available even if the system is discontinued.

Networking at the elementary school level will be an appropriate choice if there is extensive departmentalization. Electrical circuits can be installed to meet network specifications and comprehensive CMI-CAI software can be secured and contracts obtained to provide software updates and the correction of programming errors. General networks for instructional purposes should be separated from those that involve administrative applications.

Computers and communication technology are aspects of education that deserve attention now. However, student activity programs, library resources, lectures, small group instructions, parent/teacher conferences, field trips, traditional laboratory activities, vocational education programs and a reliable transportation and building maintenance system remain a central part of any education program. Balance in the utilization of resources and program development must not be jeopardized just to "keep up with the other states". The tools of technology must serve the needs of an educational system and the discipline of computer science must deserve its place in the curriculum for philosophical, social and vocational reasons.

Recommendations for Program Implementation
Grades 3-8

The implementation of the new standards as mandated by the legislature during the 1983 special session for education is a top priority for all Arkansas school districts. The Commission's position is that microcomputer instructional basic skills programs should be designed to complement the efforts of a school district to have quality education programs. The Commission's goal is to assist school districts in identifying educationally sound, cost effective programs that meet local needs and help implement those programs over a three-year period.

Effective learning through microcomputer instruction depends on the creation of a classroom climate that is conducive to learning. The use of computer-assisted instruction (CAI) assumes the existence of a classroom environment in which the teacher serves as a catalyst to pupil interest and positive attitudes toward learning. Learning through reinforcement is the key to the success of CAI and is more likely to occur if the above conditions are established.

In preparing a room for stand-alone microcomputers or for use as a laboratory with 24-27 microcomputers, the electrical work and location of work stations are critical. Inadequate electrical power and improper grounding can cause serious maintenance problems. The district is advised to work closely with the IMPAC staff or a vendor that has extensive experience with proper room preparation. Also, maintenance has been a major concern in the experimental IMPAC schools. It would be wise to purchase two complete backup systems for every 24 microcomputer systems purchased to assure 24 systems operating for student use. Since such a precaution is usually not feasible, units must be repaired and back in the classroom within 7 days or instructional classroom management problems begin to affect the morale of teachers and students.

There are a few practical considerations related to the use of microcomputers in instruction. These relate to the promise, limitations and reality of this new instructional mode. The promises of computer-assisted instruction include: more active learning, varied sensory and conceptual modes, concentrated on task learning and targeting specific student needs. Limitations and problems related to microcomputers, courseware and instructional environments include: lack of standardization of languages and disk operating systems, lack of comprehensive quality courseware especially in reading and language arts, classrooms not designed to accomodate microcomputer furniture and equipment and the increase in noise and activity related to microcomputer instruction in the classroom.

As educators, we must use common sense with respect to innovations. The human element must not be overlooked - the teacher cannot be replaced. Technology must be a servant to the teacher, and the wise use of technology by the teacher provides a way for more direct involvement between teacher and pupil - more one-on-one contact - not less.

IMPAC will move forward with caution. A statewide comprehensive program using presently available hardware and courseware is not the approach for IMPAC to follow during 1985-87. Additional programs in 47 school districts in grades 3-8 and technical assistance to school districts for program planning in grades 9-12 is a plan that is practical and will lead to the next appropriate step.

School administrators must face several realities associated with progress in the use of microcomputers in the classrooms. The decision to consider the purchase of microcomputers creates a budget priority problem. Before and after purchase, teachers must be trained and courseware selected and purchased. A decision as to how teachers and students will be initially involved and how the community will be informed can be crucial. Computers in self-contained classrooms provide the students access most of the day. Semi-departmentalization limits the amount of time that students are actually in the room with the computers and courseware. Departmentalized elementary schools generally dictate a laboratory approach and may require a teacher aide in the laboratory. In addition, equipment must be inventoried, insured and on occasion repaired.

State leadership is needed to develop a sensible approach to decision making affecting the use of microcomputers in instruction. IMPAC provides a basis for the state leadership function and the following guidelines give a plan for action in grades 3-8. School districts interested in implementing programs at the high school level are encouraged to request a copy of School District Planning, Grades 9-12, Computers in Education.[58]

In grades 3-8 IMPAC is moving ahead to establish programs in 69 Arkansas school districts by the end of the 1986-87 school year. A typical project will involve technical assistance, in-service training, program monitoring, 6-10 teachers using 24-27 microcomputer systems and numerous CAI lessons correlated to Arkansas Basic Skills objectives.

Recommendations Related to the Implementation of IMPAC Programs

1. Required computer literacy courses in grades 3-8 are the least effective way to use computers in schools. The focus should be in teaching with computers thus providing immediate justification of the cost and providing an opportunity for basic skills, problem solving and enrichment activities as a supplement to regular instruction.

2. Students in basic skills subjects grades 4-6 should spend 15-20 minutes in CAI related activities each day, 5 days in 10, over a 26-30 week period in a given subject for a total of 1100-1300 minutes during the school year. The ratio of CAI time and regular instruction time should be about 1 to 4.

3. In-service training for project teachers should relate to specific applications of computers, and generally requires 18 clock hours of instruction the first year and 6 clock hours of instruction in each of the next two years. Colleges and universities should offer Level I in-service training as defined by IMPAC for all elementary, middle school and junior high school pre-service teachers. Level II, 45 clock hour in-service courses are recommended for instructional leaders.

4. Courseware in reading, language arts and mathematics should be selected following the guidelines of the study completed for IMPAC by the University of Arkansas Center for Interactive Technology:[49]

    a. Recommended courseware should be selected as High Quality courseware by at least 2 of 5 nationally recognized evaluation groups such as EPIE and the Minnesota State Department of Education.

    b. The objectives treated in the courseware should provide at least a 60% correlation with the Arkansas Basic Skills List and the objectives related to the state assessment test - the Metropolitan Test.

    c. The IMPAC staff should make final recommendations on software by actual staff evaluations and input from teachers in experimental test sites.

5. In program development, teachers in grades 4-8 should be given the greatest priority in using basic skills CAI. A minimum program should involve two consecutive grades and a maximum of two subjects. Teachers in self-contained classrooms should have the computers in the classroom at a 1/6 ratio.

6. Teachers in departmentalized classrooms should study the laboratory CMI-CAI hard disk network program and determine if a laboratory and the schedule it imposes is appropriate for the school. The loss could outweigh the gain considering the present technology and its cost and reliability. Stand alones in departmentalized classrooms do not provide the basis for a cost effective program.

7. CAI or CMI-CAI IMPAC programs should be designed for all students and not just special need students. However, remediation of students based on needs established by Arkansas Basic Skills Test in grades 3, 6 and 8 is encouraged in extended day or special summer classes.

8. Teachers should utilize CAI as supplementary comprehensive instruction in one or two subjects, usually mathematics and reading or language arts, to target specific objectives that need remediation, as reinforcement or review which relate to daily instructional activities and as review over several objectives preceding comprehensive evaluations.

9. High standards for electrical power, IMPAC hardware and software technical support, maintenance support by vendors and a program of preventive maintenance by teachers are crucial to the success of microcomputer instruction programs. School districts should budget for repairs once equipment warranties terminate. United Parcel Service, Federal Express or a comparable service is highly recommended as a means to a one-week turn around on repairs.

10. Problem solving, science, and word processing software, such as Bank Street Writer, can greatly enhance supplementary instruction in grade 6.

11. A formal microcomputer literacy or awareness course is not recommended for learning about microcomputers in the elementary school. Learning about computers and communications technology should be integrated into the total instructional program of the school. Students should learn about computers by interacting with CAI and problem solving programs which require loading and running courseware, care of equipment and software and using editing features.

Recommendations for Additional Research

It is recommended that student performance in several IMPAC fourth grade classes be monitored for at least two additional years. Also, pretest and posttest data should be obtained on students participating in the IMPAC junior high school experimental programs. Finally, a fifth treatment for experimental purposes should be developed that meets the following criteria:

1. Select a school with departmentalization in grades 5-6

2. Place 12-14 microcomputer work stations in a regular classroom (900 square feet) with 12-14 regular work stations

3. Use the CMI-CAI IMPAC Learning Systems in mathematics, language arts and reading with a minimum of 45 megabytes of storage

4. Have students in 8-10 classes with enrollments of 24-32 work in the lab every other day in a given subject under the direction of a teacher and without help from an aide

5. Have half of the students work on the computers 12-20 minutes each day while the others take diagnostic tests, do homework or other supervised activities.

Steps in Implementing Microcomputers in Instruction[56]

1. Appoint a local program coordinator

2. Appoint a planning committee and begin Level I and where feasible, Level II in-service training that includes:

    a. Operating skills
    b. Terms and definitions
    c. Educational uses of computers
        - Drill and practice
        - Tutorials
        - Games
        - Simulations
        - Information retrieval
        - Applications programs
        - Materials generation
    d. Ways of scheduling use in building and classroom
    e. Software evaluation
    f. Microcomputer Instuctional systems
    g. Hardware selection

3. Identify those teachers needing special computer concept training and arrange for in-service by software vendors, higher education institutions or state department personnel following Level II and Level III guidelines.

4. Develop goals and objectives for instructional applications of microcomputers.

5. Identify software to accomplish objectives

    a. Cost of software, backups, storage and replacement disks
    b. Computer capabilities needed
    c. In-service required
    d. Classroom management requirements

6. Find hardware on which software will run

    a. Determine cost of each computer, peripherals, tables, chairs and electrical wiring
    b. Estimate cost of maintenance
    c. Identify how many computers are needed

7. Estimate number of students affected

8. How many computers are needed in each building

9. Determine how much money is available from funding sources (local, state, federal, PTA and business industry)

10. Order programs in priority so that greatest needs are met first

11. Develop a 2 to 3 year timeline to purchase desired hardware, software, train teachers and implement programs

12. Establish plan for purchase and maintenance of hardware and software

13. Establish plan for on-going support and training of teachers

Basic Information for Future Reference

- School district
- Superintendent
- Project Director
- Name, position, training of planning committee members
- Existing programs developed using federal, state or local funds
- Programs developed for possible federal, state or local funding during the current year.

Establishing Operational Procedures

- Program objectives
- Learner outcomes
- Visits to pilot projects and research involved in establishing objectives
- Grade levels affected
- Number of students affected
- In-service training plan
- Teachers involved and their qualifications
- Courseware to be used
- Microcomputer systems to be used
- Bidding process
- Service and maintenance arrangements
- Specifications for furniture and electrical wiring
- Calendar of activities to implement programs
- Technical liaison person
- Community involvement
- Sources of funds
- Evaluation procedures

Guidelines for Developing IMPAC Approved Programs

Computers have been used in schools basically in two different areas, for administrative purposes and in the instructional program. In the latter area schools have used the microcomputer in diverse ways to teach: about the computer (computer awareness); computer programming and computer science; computer applications (e.g. bookkeeping); and subject areas (e.g. math). In the elementary school we recommend the use of the computer as an instructional tool to assist teachers in the delivery and management of their basic skills instructional program.

As an instructional tool, microcomputers can be a delivery system for courseware that supplements the basal instructional program. Computers need to be used in cost effective ways for instructional purposes that can raise achievement levels. Specifically, computers should be both effective and efficient tools of instruction to teach, drill, test and place children in an instructional program. This will set the stage for problem solving and management applications.

There are several different ways of using computers in the classroom. Schools should carefully study the instructional applications of computers and select the ones which will be the most effective in the local situation.

Computer-Assisted Instruction

1. The kinds of instructional tasks a computer can do:
    a. Tutorial tasks such as
        - giving a rule
        - defining terms
        - presenting information
        - asking questions
        - responding to the learner

    b. Drill and practice in
        - spelling skills
        - math problems
        - rote learning
        - punctuation
        - rules of grammar

    c. Problem situations in
        - simulations of real-life events
        - games which help in the discovery of new relationships
        - graphical form

2. The ways a computer can do these tasks:
    a. Give an immediate response to a student so that
        - errors can be corrected
        - errors will not be repeated

b. Allow learning to be paced by the learner or the teacher
   - through alternatives in the speed of presentation
   - through repetition of material if needed

c. Can move from one section of a lesson to another section
   - for further instruction
   - for more practice
   - to take a test
   - for a different presentation of the same skill

d. Can present a problem to be solved
   - offers option in solving
   - responds to students input
   - offers further options (e.g. finer distinctions, more complex variables)

Computer Managed Instruction (CMI)

1. Student testing on the computer for mastery of:

   a. State basic skills

   b. School district and/or school building instructional objectives

   c. Objectives in a specific content area

2. Placement of students in a skills continuum for instructional purposes:

   a. Reteaching of skills not mastered from previous instruction

   b. Teaching new skills to be mastered at the current instructional level

   c. Instruction may or may not be delivered by the computer through CAI

3. Records management by:

   a. Storage of information about mastery of specific skills in the computer

   b. Analysis of student achievement by use of information from testing

   c. Printing of hard copy (paper copy) of this information when needed

4. Prescription of instructional activities for an individual student or groups of students:

   a. Derived from data input by teachers

   b. Generated by computer after students are tested

Basic Skills Mastery Management Systems (C-AIM)

1. A specialized CMI system based on the Arkansas Basic Skills which will include:

   a. Diagnostic capabilities to evaluate students 3-8 in reference to their mastery of the basic skills in math and reading

   b. Prescriptive aspects which indicate what skills need to be taught and provide suggestions of materials that can be used to teach these skills

2. An evaluation center should be provided in the school building in a room to accommodate the following equipment:

   a. Hardware and Peripherals
      (1) Four to eight microcomputers systems on which the computer management system is designed to run

      (2) Networking equipment appropriate for the microcomputer systems

      (3) Peripheral devices including two disk drives, a printer, and appropriate cables

   b. Tables for computers and other equipment

   c. Student chairs

3. The management program will:

   a. Be sorted on a 5 1/4 inch floppy disk to allow speed in accessing questions, student records and prescriptions

   b. Include test questions that will adequately determine skills mastery both in the scope of their content and by the number of questions

   c. Generate records that will reflect:
      (1) each student's mastery or non-mastery skills

      (2) a group profile indicating a group of students' mastery or non-mastery of skills (e.g. a class roster)

   d. Generate prescriptive information from data supplied by teachers to reflect materials available in their classrooms and should include the correlation of skills to textbook materials, worksheets, computer software and learning kits

Program Coordinators and Key Operators

There are two leadership responsibilities that must be fulfilled in any school district that is effectively using microcomputers for basic skills instruction. There must be a program coordinator who provides direction for the overall program and a key operator who provides technical assistance related to hardware and software - especially maintenance and software backups.

A program coordinator is an instructional leader, usually a principal or curriculum director, who is responsible for learning about the procedures for developing program components using computer and communications technology to enhance instruction. Identifying program types, courseware, hardware, in-service education needs and support services are the responsibility of the coordinator.

A key operator is usually a teacher or administrator who has the interest and ability to secure the technical information and skills related to a particular microcomputer or communications system and its related courseware or utility programs. The person serves as a "trouble shooter" for teachers using the microcomputer systems.

Incorporating Computers into an Instructional Program

Schools need to assess their own staff, facilities, instructional goals and budget in order to determine whether computers should be placed in the classrooms or in a computer lab. The following guidelines are presented in order to help schools make that decision.

The number of classes in a building as well as the number of students per class will influence this decision as the cost effectiveness of computers in the classroom or in a lab is determined. Within a self-contained classroom of 18 to 27 students at least four microcomputers will be needed in order for all students to have sufficient time on the computer to significantly affect their mastery of skills.

A laboratory should have a sufficient number of computers for each student within a class to be able to work on his own computer. This probably means 24 to 27 computers. In order for each student to work on the computer 20 minutes five days in ten, no more than 10 classes could be scheduled into a lab each day. The choice between use in class or a laboratory approach should be influenced by instructional purposes and the organizational structure of the school. It should be noted that a full-time aid, paraprofessional or community volunteer is usually needed to supervise a laboratory.

When microcomputers are placed in a classroom as an instructional tool, the teacher is faced with some instructional decisions. How should computer instruction be integrated into the instructional program? When should use of the computer be scheduled? How long should students remain on the computer? Should some instructional activities on how to use the computer be completed before a student is allowed to work on the computer? There are research data and classroom experiences that can help in making these decisions.

Research indicates that the optional on task time for computer instruction in a given subject area is 12 to 20 minutes per day and 1200 to 1500 minutes per year. Fifty percent less time will decrease instructional effectiveness; fify percent more time will not increase instructional effectiveness and may eventually have the effect of over-exposure. That is, students may become bored with computer-assisted instruction if it is not used with prudence. Also, extensive time on the computer affects the time available for regular instruction.

Experience in the classroom shows that, although four times a week is the optimal schedule for a given subject area in a self-contained classroom, many teachers do not have enough time to implement that kind of schedule in their classrooms. Because of time constraints brought about by departmentalization and pull-out programs a teacher may be able to get only half of a class on the computers during the reading or mathematics instructional time period. Therefore, it is recommended that a two-week cycle be established which insures that each student works 20 minutes on the computer five days out of ten in a given subject.

In the context of a two-week time schedule, the computers can become a learning center through which students rotate at an established time in the instructional day. The computer is used as another way of presenting instruction to reinforce and supplement the teacher's direct instruction. If a student is placed at his appropriate instructional level he can work independently, and yet the teacher can be confident that he is receiving sound instruction with appropriate feedback.

If a school decides to establish a computer laboratory for use by several classes, some of the same instructional questions must be answered. In this case greater care must be taken to assure that computer instruction is an integral part of classroom instruction and does not "drift" into a separate subject - computer awareness or programming. However, some teachers may prefer the lab arrangement so that they can establish a schedule for computer instruction and have the whole class "on the computer" together. It is recommended that an aide be assigned to the laboratory full-time to assist teachers by maintaining the computers and courseware. This allows teachers to concentrate on instructional matters.

A class probably should be allotted a twenty-five to thirty minute time slot each time it is scheduled into the lab. This would assure about twenty minutes on task, allowing for time spent entering the lab, accessing the instructional program and leaving in time for the next class to enter.

Again, although some research indicates that a class should be in the lab four days a week, the reality of school schedules and finances may dictate a less frequent schedule. Classes could alternate days in the lab and thus receive computer-assisted instruction five days out of ten. This would allow up to twenty classes the opportunity for computer-assisted instruction in one subject, or ten classes in each of two subjects.

Analysis of Three Major CAI Procedures Used by Teachers

1. Comprehensive Basic Skills Instructional Courseware

    a. Start each student at the beginning of the instructional program
    b. Let each student work at own pace until all lessons are mastered
    c. Correlation of CAI to the school's basal curriculum depends on how well the objectives covered by the courseware match up with the objectives of the basal textbook

Advantages	Disadvantages
- Good review of some students	- Teacher not in total control
- Good reinforcement for some students	- Students at varied levels
- Self-paced so students are experiencing success	- Student monitors may be needed
- Teacher selects the courseware	- Some programs will be below the student's instructional level

2. Specific Skills Instructional Courseware

    a. Students could be placed to work on objectives they have not mastered.
    b. The entire class or a group of students could be placed to work on the objectives being introduced in the regular instructional program.
    c. Objectives could be reviewed as needed before testing.

Advantages	Disadvantages
- The teacher selects the specific objective to be mastered or reviewed and is in total control	- Cannot take full advantage of computer management features
- Computer instruction is fully integrated into broader instructional program	- May necessitate frequent loading and the running of a variety of courseware resulting in a loss of on-task time

3. Drill and Practice Courseware

    a. Teacher instructs individual, small group or large group in a skill by assigning the student(s) to the computer for drill and practice on that skill (e.g. math problems or punctuation).

    b. Teacher assigns students task of learning a list or a body of information; computer program drills the student (e.g. spelling words or state capitals).

Advantages	Disadvantages
- Computer work provides another way of immediately reinforcing teacher's instruction	- No computer management is available
- Teacher selects and monitors progress of students	- Will require frequent changing of disks

Managing Microcomputer Instruction Activities

The purpose of this section is to describe classroom management procedures that seem appropriate with respect to the various applications of microcomputer instruction. The material is presented in a question and answer format because the technique provides a way of clarifying techniques that can enhance effective management related to CAI.

QUESTION: How do you label and store courseware?

ANSWER: Courseware disks may be color coded by using blue labels for mathematics, yellow for reading, green for language arts, pink for social studies and red for science. White labels may be used on all other courseware. Plastic storage boxes that hold 10 diskettes each for programs of 6-10 diskettes and storage containers holding 60 diskettes provide ways of storing diskettes by subject. The boxes of disks may be placed on the table by the computers when that courseware is being used.

QUESTION: What precautions should be taken in handling diskettes?

ANSWER: When a student finishes with a disk, it should be returned to the disk sleeve and then put back in the storage box. The metallic part of the diskette should never be touched or placed on the computer, disk drive, monitor or printer. Never take the disk out of the disk drive while it is attempting to load a program. If a program does not load properly, turn off the computer, disk drive, remove the disk from the disk drive, turn on the disk drive and then after turning on the computer, try to load the program again. Students and teachers should follow these procedures.

Courseware should be stored in an air conditioned office during the summer for protection from intense heat.

QUESTION: What is the role of student classroom monitors?

ANSWER: Several students in the typical elementary school classroom have microcomputers at home. A student that has experience with a microcomputer system used in a particular classroom should be trained to help other students when they have difficulty using the computer.

QUESTION: What is supplementary comprehensive courseware?

ANSWER: Supplementary comprehensive courseware refers to a mathematics or reading and language arts set of diskettes that usually store lessons which cover most of the basic skills on the subject at specific grade levels. For example, Fundamentals of Mathematics is a courseware program that has 81 lessons that relate to basic math skills in grades 4-5-6.

QUESTION: What is the role of the key operator?

ANSWER: A key operator in a school determines if a diskette needs to be replaced, makes or helps make backup copies of public domain courseware and determines when a piece of equipment needs to be repaired. By using equipment from various classrooms, the key operator may switch disk drives, monitors and computers around until it is determined exactly which piece of equipment is not working. Sometimes it is the diskettes and not the disk drive. Adjusting all controls properly, checking to see if the power cords are working and that all plugs or attached cords are secure are routine activities of a key operator to minimize maintenance costs and help keep microcomputer systems operating properly.

The teachers and students in any school must be trained to handle diskettes properly and return them to their storage boxes. The equipment should be cleaned with a soft cloth once each week and all equipment covered at night and on weekends. Large plastic leaf bags or commercial plastic covers may be used to protect the equipment from dust overnight and on weekends or during vacation periods.

QUESTION: What does it mean to license courseware to a school?

ANSWER: Licensed courseware is usually related to courseware on a hard disk microcomputer network. Since a network usually has 4 to 30 microcomputers the vendor may price courseware valued at $100 for 3 to 4 times that amount if you agree to use it only in a designated laboratory situation. Courseware may be licensed to a district in such a way that you can make as many copies as you want in your school district, but copies may not be made available to other districts.

QUESTION: Should students be allowed to work problems on a tablet next to the computer while using the computer?

ANSWER: Generally the answer is yes. An exception might be memory work related to spelling or learning number facts in arithmetic. Be sure enough table space is provided so students can work problems just as they would at their desk.

QUESTION: What special preparation should be taken in wiring classrooms for computer use?

ANSWER: If the school district does not have a licensed electrician on the maintenance staff, the district should employ a licensed electrician to make any needed changes in the wiring. Check to be sure there is a good earth ground at the circuit breaker box. A power surge protection device should be installed in each classroom where the computers are to be used. Electrical wires should be run along the wall in a conduit and then an outlet receptacle installed for each microcomputer system.

A CMI-CAI network lab presents special problems because a network is sensitive to induced current and noise or "dirty" electricity. A completely dedicated circuit should be run from the switch box to the lab. The circuit should have its own ground. Power surge protection devices should also be used. All wires should be placed in conduits and the network (trunk line) should be kept away from florescent lights and extension cords.

QUESTION: Should the hardware be turned off during a heavy rain or storm in which there is severe lightning?

ANSWER: If there is lightning occurring near the school, the microcomputer should be turned off and unplugged. However, a general rain or light snow in which there is little or no lightning should not prevent the use of the computers for instruction. In an ice storm the general rule is to turn off and unplug the systems if the lights start flickering.

QUESTION: Should computers be covered by insurance?

ANSWER: A two hundred dollar deductible policy is recommended. On the other hand, including the microcomputer hardware on the school's general equipment insurance policy is less expensive. However, such policies usually have only a one thousand dollar deductible feature.

QUESTION: What is an equipment warranty?

ANSWER: A warranty means that the company will repair or replace the defective equipment at no cost within the warranty time period. In a formal bid the vendor should indicate how this will be done and the time required. An equipment warranty is usually ninety days for computers, monitors, disk drives and printers.

QUESTION: How do you get your microcomputer equipment repaired?

ANSWER: When a school district takes bids on equipment, the bids should require that the vendor give a minimum of seven day service turn around time on equipment under warranty and equipment out of warranty. The appropriate official calls UPS or Federal Express and the defective equipment, properly boxed and labeled for shipment, is picked up at a designated location the next day. The vendor either repairs the equipment or sends a replacement unit within three to seven days. Any bid should cover the maintenance procedure in such a way that the vendor's bid includes the pick up and delivery cost during the warranty period.

QUESTION: Should covers be purchased for microcomputer hardware?

ANSWER: Accumulation of dust is the cause of some keyboard, printer and disk drive defects and can be prevented by using appropriate covers at a cost of less than $25 per system. The number of covers required should be kept to a minimum since the activity of covering the systems occurs each day.

QUESTION: In a self-contained classroom, except for the students that are pulled out for special instruction, students are in one room all day. What is a typical week of computer use like in that instructional setting?

ANSWER: Students can work on math 12-20 minutes each day 4 days in 10 and reading and language arts 12-20 minutes each day 4 days in 10. Two days in 10 programs that have game formats or provide problem solving lessons may be used for motivation.

QUESTION: Should a school purchase backup equipment and how many sets of courseware is needed in each classroom?

ANSWER: It is wise to purchase one complete backup system (computer, disk drive, monitor and printer) for every 10-12 systems purchased. The extra systems are used for regular instruction. However, the computers automatically are used as replacements if needed. This helps prevent downtime especially in schools located over one hundred miles from the maintenance site.

One complete set of courseware for every two computers is recommended. If management courseware is used and only one management disk is available for every four computers, two of the microcomputers should be located back to back with the other two so that students can hand each other a disk directly and eliminate passing a disk or getting up and taking it to another student. If courseware is interactive it cannot be shared during its use, one set of courseware per computer will be needed. It takes about 3-4 minutes for a student to get a lesson loaded and ready to run. It takes only about 1-2 minutes to get the computer ready for the next person.

QUESTION: Is a clock or timer needed in a classroom so students will know when to go to the computer?

ANSWER: A clock should be located near the computers so each student in the room can see the time. Students automatically move to and from the computer usually in 20 minute time slots. Each student records the date, his name, the lesson he is working, time on and time off. The teacher should designate on the bulletin board the lessons to be worked each week.

QUESTION: What are teacher utility programs and authoring systems.

ANSWER: Authoring systems, for example, may be used to develop lessons in spelling, capitalization and on the metric system. The teacher actually develops and stores lessons on a disk. Grade book utility programs keep a record of grades. Some utility programs generate and print out worksheets in mathematics for drill and practice.

QUESTION: Describe how a school might use computer-managed instruction (CMI).

ANSWER: Specifically, the C-AIM program uses four to eight microcomputers networked to a dual disk drive. Students are scheduled to be tested on basic skills in reading and mathematics every three to six weeks. They take the test directly on the computer and a report is generated that shows the extent to which each student is mastering basic skills. The report indicates which objectives were mastered and which were not mastered in certain units. The printout also gives prescriptions that help the teacher identify CAI and other materials that can be used to remediate the skills that haven't been mastered.

QUESTION: What are some of the most important things that have been learned in the IMPAC program about using microcomputer instruction?

ANSWER: Many things have been learned. However, five will be given as illustrations.

First, be sure you bid your equipment and courseware so that you get good service. Be sure the electrical circuits are installed properly. The morale of teachers and students is affected when equipment or courseware doesn't work.

Second, a Level I in-service training program (16-24 clock hours) is a must for all teachers directly involved in microcomputer instruction. In general, a school district may take one complete year to train teachers in the use of CAI and CMI applications of microcomputers, select and bid courseware and hardware and gain experience with the management procedures required. At least one additional year will be needed to refine the program so that it is effectively supplementing instruction.

Third, for stand alone computers have at least one set of courseware for every two computers and enough storage boxes to keep them organized. One set of interactive courseware is required for each computer. For a network, CMI-CAI courseware on a 45 megabyte hard disk drive involving 16 or more computers must be secured under a license agreement.

Fourth, making the choice between placing microcomputers in the teacher's classroom or placing them in a laboratory determines the dynamics of how the instructional program will operate. Continuous use with a variety of applications and its associated management problems represent a plus and minus for in classroom use. Targeting specific basic skills deficiencies using comprehensive courseware on a hard disk network under the direction of a paraprofessional and being tied to a regimented schedule are a plus and a minus for laboratory use.

Finally, don't let the computer control your instructional program. make the computer work for you. Let it do things for you that save you time and energy. Don't let computer-assisted instruction be extra - let it replace some of the activities you are presently doing through worksheets or workbooks.

RECOMMENDATIONS FOR SELECTING AND PURCHASING HARDWARE

Hardware refers to the microcomputer itself and the equipment needed to make it operable. In general, for schools a microcomputer system with a minimum of 128K RAM memory, a monitor and a disk drive is recommended. Expandability of memory is becoming increasingly important. The keyboard should be similar to that on a typewriter. The application will determine whether a printer is necessary.

If eight or more microcomputers are to be purchased, networking might be considered. That has been done successfully in numerous schools and with a hard disk, memory capacity and speed of accessibility can be increased. Networking also allows for the sharing of programs and peripherals among several computers. For courses requiring heavy use of a printer and the computers are not networked, a black box switch can be used to link three or four computers to one printer.

In purchasing hardware devices it is also recommended that the number of different vendors be kept to a minimum. This encourages vendor accountability for any problems that may be encountered with the hardware. A more detailed discussion of selecting microcomputers and developing bid specifications and maintenance agreements are presented in the following sections.

Selecting a Microcomputer and Peripherals

The decision facing many educators at this time is which of the several microcomputers that are currently available should be considered for purchase by the local school district. Unfortunately, there is no precise set of factors that can lead to a "best brand" selection because there is no single microcomputer that is right for every educational situation. The identification of the specific classroom applications of a microcomputer system, a hands-on familiarity or on-site observation, a detailed listing of the microcomputer configuration and the availability of quality courseware are aids to hardware selection.

The following observations do not provide a recipe for successful hardware selection. However, these statements are the result of careful thought about the essentials in selecting microcomputer systems for instructional applications at the elementary school level.

1. Sufficient courseware is available for elementary school basic skills applications to give consideration to the purchase of the Apple IIe and Commodore 128. The MS-DOS compatible Tandy 1000 is also a contender as its price drops to more moderate levels and more courseware is available.

2. Any microcomputer system should include at least a CPU with a minimum of 128K RAM memory, a monitor designed for use with that specific computer and a disk drive. Future needs should also be assessed to determine if the

system under consideration has the expansion capabilities necessary in meeting long-term goals.

3. In the case of classroom configurations involving more than four (4) microcomputers, consideration should be given to the inclusion of a printer. A bi-directional tractor feed printer is recommended. Investment in a letter quality printer is not recommended.

4. Except for special function keys related to graphics and data entry, the keyboard should function like a regular typewriter (QWERTY) keyboard so that good keyboarding skills may be developed.

5. Microcomputer systems purchased in quantity should be capable of networking to either a floppy disk or hard disk up to a minimum of 16 systems. Networks of up to 32 systems involving a hard disk are effectively utilized in schools. Flexibility in microcomputer configurations is imperative for cost effective applications over a five (5) year period.

6. Color, sound and high resolution graphics have been essential to quality courseware. Expenditures for these features as extras should be justified on the basis of their effectiveness in concept development courseware.

Compatibility of Software and Hardware

Software programs are stored on a diskette in such a way that only certain microcomputers, without modification, can run the programs. The program instructions are organized on the diskette according to a certain format. The microcomputer loads and runs the program using the disk operating system which is designed to read the program instructions off the diskette. The most common disk operating systems for which there are large amounts of courseware are Apple DOS, Commodore DOS, TRSDOS, MS-DOS and CP/M. Some microcomputers with additional chips or special systems software can run programs formatted using one or more of these disk operating systems. For instructional applications, schools are advised to purchase only microcomputers that have disk operating systems that will load and run courseware that is expected to remain in abundant supply. When purchasing various pieces of hardware (printers, disk drives, computers) care should be taken that all hardware items are compatible.

Microcomputers have a variety of features and capabilities. It is important to evaluate each system under consideration in terms of its ability to meet the district's instructional needs. The following list includes the factors that should be considered in the assessment of microcomputer systems.

Cost - The cost of microcomputers for educational purposes varies greatly from less than three hundred to about four thousand dollars. Cost comparisons must be made in relationship to machine capabilities and software programs that are available. Cost most often reflects memory size, language capacity and the type of storage device available. When comparing costs of various machines, remember to be sure to compare machines with similar configurations and capabilities.

Memory - There are two kinds of memory in a computer - RAM (random access memory) and ROM (read only memory). The RAM determines the size of the programs that can be run on the microcomputer. A program requiring 64K of memory will not run on a computer that has only 48K memory. The ROM is used for storing programs that are generally put in by the manufacturer as part of the operating system of the computer. The amount of memory available will often limit the courseware that can be run on the computer. A 128K memory is considered a minimum for courseware presently being developed.

Peripherals - These are devices that are accessories to the computer; however, often the computer will not function properly without certain peripherals.

1. Floppy or hard disk drives - These are used to augment the memory capacity of the microcomputer. These devices can store and play back programs. Hard disk drives are more expensive than floppy disk drives, but provide faster and more reliable storage and retrieval of information. Hard disk drives are usually used when microcomputers are networked.

2. Printers - If printed hard copies of student records or instructional prescriptions are desired, or if the microcomputer is to be used for word processing, the purchase of a printer is essential. The types of printers that can be used with a given microcomputer should be determined, as should the supportive items such as an interface card that may be necessary to use the printer. The printer's speed and ability to reproduce graphics should be considered. Basically two types of printers are available (1) a dot matrix printer and (2) the letter quality printer. The letter quality printer will be much more expensive and is only necessary if high quality manuscripts produced through word processing are to be done.

3. Monitor - The purpose of a monitor is to have a screen display of the output of the computer. In some microcomputers the monitor is built into the main unit. In others, it is detached and considered a peripheral. When this is the case, the monitor selected should support the hardware purchased. Television sets can be used as monitors for some microcomputers. Generally a monitor has a higher degree of resolution and is more reliable than a television set. If the computer has color capabilitites, consideration should be given to purchasing a color monitor. Generally, if the computer is to be used for word processing the green or amber screens are recommended.

4. Modems - Modems allow microcomputers to "talk" to other computers over telephone lines. A modem would give the microcomputer access to information networks as well as potentially enabling it to be used as a "dumb terminal" for communication with other computers. In Arkansas the microcomputer is currently being used to connect schools and the Department of Education through Connect*Ed. Instructional applications of modems are limited at the elementary school level.

Software - Collectively the programs that are loaded into the computer are known as software. Complete instructional packages for computer-assisted instruction/computer-managed instruction are referred to as courseware.

Generally, software is available to suit a variety of educational needs. There is a wide variety in the quality and the availability of specific items for a particular machine. The software market is rapidly expanding; however, there is no assurance that educationally effective software developed for one computer will eventually be adapted for other models. An attempt should be made to determine the availability of software and materials to meet the stated objectives for the school program.

Screen Display - The options for screen display ranges from 20 to 80 characters in width and 16 to 32 lines. Many microcomputers have upper case letters only.

Graphics - The greater number of dots or blocks that can be used to display a graphic, the higher the resolution (greater the detail). Some computers are capable of character graphics programming while others have higher resolution graphics. Many programs such as LOGO will not run on machines with only character graphics.

Keyboard - There are two basic types of keyboards available on computers. The typewriter-like unit with keys you depress and a flat (membrane) unit with keys drawn on a smooth surface that is pressure sensitive. Students with any keyboarding experience will respond positively to the typewriter-like feature. Many keyboards feature special function keys - these are generally preferred if they are not accessed by the regular typewriter keyboard. Another option that is often a major consideration is the presence of a separate number pad.

Sound and/or Music - This feature comes standard on some microcomputers and can be added at additional cost on other models. Sound is usually considered a motivational feature for young users.

Color - Computers that have color capabilities display a range of numerous color combinations. Color is a consideration in the reinforcement and motivation of young students, for highlighting, contrasting or increasing the appeal of the program.

Networking and/or Expansion - To lessen the cost for peripherals such as disk drives and/or printers, networking capabilities can be explored. Care must be taken in assessing the networking capabilities so that the desired courseware will in fact work on the network. Most of the "protected" programs from commercial sources will not load onto the network without modification. Several expansion capabilities are available for additional costs including interactive videotape and videodisc connections.

Languages - BASIC (Beginners' All Purpose Symbolic Instruction Code) is the most common language for the microcomputer. Microcomputers differ in the type of BASIC used. One should not assume that software written for one brand of microcomputer will run on another brand. Many computers have the capability of being programmed in other languages. To adjust the computer for use with other languages requires the purchase of a language modifying item such as a language card or cartridge. The following languages are sometimes used:

1. Pascal - This structured language is useful for those interested in more advanced computer programming.

2. Pilot (or other authoring languages) - This authoring language allows teachers with no programming experience to write computer-assisted instruction programs for use with their own classes. However, such courseware is seldom cost effective when compared to good commercial courseware.

3. Fortran (Formula Translation) - This scientific language is useful for dealing with problems in science and engineering.

4. LOGO - This highly interactive language is designed primarily for use with young children.

Equipment Bid Specifications and Maintenance Agreements

When securing equipment, consideration should be given to the development of bid specifications and maintenance agreements. Such specifications and agreements cause the local school district to describe specifically what equipment is to be purchased, the appropriateness of functionally equivalent equipment and the type of maintenance expected.

In most cases the school district should require that a vendor bid on the entire system as a prime contractor. The selected contractor should be required to assume all responsibility for the equipment and be the primary point of contact with regard to equipment, maintenance and support. The vendor should be an authorized service dealer for the microcomputers being bid.

Criteria for evaluating microcomputer systems in the context of a bid are being used in the evaluation of bids submitted relating to IMPAC programs. You are encouraged to use this criteria in evaluating bids. Certainly the criteria reveals in part the Commission's view that evaluation of bids may be an important process especially in large equipment orders. Low bidders with a poor service record should not automatically receive a bid.

1. Evaluation Criteria Related to Equipment Specifications

The selection process should be based on a predetermined methodology and set of evaluation criteria. The evaluation criteria should reflect the following objectives and considerations:

a. The ability of the vendor to satisfy the school's overall computer based instruction goals

b. Meeting the minimum mandatory requirements set forth in the specifications

c. The total cost of the system, including transportation, installation, maintenance and training

d. The level of vendor assistance, aids and promptness of the installation effort

e. The level of vendor maintenance support for the hardware

f. The number and type of vendor references specified

g. Emphasis should be placed on the clarity and conciseness of vendor proposals. Failure to completely meet any one of the mandatory requirements including bid format and submission of the required number of copies at the time of bid opening, may be sufficient cause for rejection of the vendor's proposal.

In addition to the criteria noted above, the skills, facilities, experience, previous work and financial standing of the bidder; and the quality, efficiency and construction of the equipment proposed to be furnished should be considered.

2. Maintenance Support Requirements

The vendor should assume total responsibility for all the hardware purchased. Any vendor proposing the hardware in response to a bid should certify that maintenance can and will be provided in accordance with bid requirements.

Maintenance service should be available to the school on-call from 8 a.m. to 5 p.m., Monday through Friday. This plan should offer, during the principal period of maintenance, a minimum of next day response to a trouble call. The maintenance plan bid should describe how the bidder will provide maintenance service, identify all parts required and outline all associated costs.

If any component in the computer based instruction system remains inoperative for more than seventy-two (72) hours from time of notification of failure, the school district should reserve the right to exercise the following options:

a. Suspend payment of maintenance on the malfunctioning system(s) or machine(s) rendered unuseable. Maintenance payments would resume at such time the system(s)/machine(s) are returned to an acceptable service level determined by the school district.

b. Allow the vendor to replace malfunctioning system(s) or machine(s) with equipment of equal or greater capacity at no expense to the school district.

Contracted monthly maintenance should be proposed and begin after expiration of the defined warranty period offered in the bid. If maintenance charges are to escalate from year to year during the maintenance contract period, a maximum annual percentage rate of increase should be stated and evaluated as such. Escalative charges should only be put into effect at the beginning of the school district's fiscal year (July 1) and only if preceded by 90 days written notice. Maintenance charges should be stated on a per unit basis.

Time-and-material maintenance should be proposed and begin after expiration of the warranty period offered in the bid. Bidders should state the period of time all associated costs for such service will remain in effect. A bidder should state their experience factor as regards mean time between failure for the equipment proposed.

A bidder should provide a toll-free telephone number (or one which will accept collect calls) through which the school district may obtain operational diagnostic assistance for hardware.

A bidder should provide a detailed explanation of both maintenance programs proposed by the vendor to provide service at the school district so as to insure attainment of a goal of maximum up-time. The explanation should address the following points:

1. Parts supply and availability

2. Technical personnel support giving numbers and skill levels

3. Backup support for technical personnel

4. Backup equipment availability

5. Length and terms of warranty on each system/software

6. Average turn-around time for requested remedial maintenance

7. Time and material rates

8. A list and cost of any spare parts that the bidder suggests the school district should keep on-hand

The school district should be able to select either monthly contracted or time and material maintenance plans. However, the cost of the bidders proposal should be either a monthly or time and material contract for maintenance of equipment.

Delivery and Installation of Equipment

Delivery and installation of all hardware should be completed within a specified (usually 30-45 days) time after bid award.

The bidder should assume responsibility for:

1. arranging for equipment transportation to specified school district receiving center

2. the risk of loss and/or damage during shipment of all equipment

3. the installation of all the microcomputer systems excluding preparation of the physical facility

4. outlining in detail the requirements for required modification of the physical site, if any, to accommodate installation of the proposed hardware

5. all necessary cabling

6. describing in detail their methodology and criteria for acceptance testing and certification of each system as "customer ready"

Bidders should describe the remedial action to be taken following certification of system as "customer ready" in the event any system fails to meet the school district's standards. A performance (90% overall up-time) calculated as follows is recommended:

$$\frac{\text{(Productive time - Downtime)}}{\text{Productive time}} \times 100 = \text{Uptime percentage}$$

Productive time is defined as those periods during which the system is scheduled for operational use by the school district.

Acceptance of Equipment

The school district should provide a letter of acceptance when all requirements under specifications have been met.

Training

Formal customer training courses for use of the hardware should be required if needed and should be detailed as to cost and content in the vendor proposal. The bidder should provide a specified number of hours of training for the school district.

On-site training should be specified for the teachers in the operation of the hardware after the equipment has been delivered, installed and tested for operation in accordance with the manufacturers specifications. It is recommended that training be available within fifteen (15) days after the hardware becomes available for operational use.

Documentation/Manuals

Documentation for each of the microcomputer systems should include, at a minimum, the following:

1. User procedure manual for microcomputers
2. Microcomputer system manuals
   (1) System operating manual
   (2) Maintenance manual
3. Courseware manuals (if any)

The bidder should provide unit costs for all documentation identified above that would apply to subsequent school district purchases.

Bidders should state their policy as regards reproduction of manuals for the exclusive use of school district employees and students for educational purposes.

Pricing

All charges associated with the proposed hardware should be included on the Bidders Price Sheet and should be included in the costing evaluation. These prices should include the following:

1. Equipment pricing
2. All cabling costs, if additional

3. Maintenance costs
4. Maximum amount of annual increase in maintenance cost which the vendor may charge (NOTE: This should be quoted in terms of maximum dollar or percentage increase over previous year)
5. Shipping date estimate and anticipated date of installation
6. Installation charges, if any.

Summary

In preparing a bid be sure to cover the following items:

1. Accept bids only from authorized service dealers
2. Detail description of equipment
3. Vendor clarification of warranty and how equipment will be repaired or replaced
4. Clarification of maintenance available after warranty
5. Expectations for on-site installation, including electrical requirements, set up and certification that equipment is working using performance test
6. Training and orientation of staff
7. Documentation manuals and software required to use the system
8. Prices on each item in the main bid request
9. Terms of payment
10. Length of term of the bid
11. Prices of optional items that enhance the use of the system should be included since diskettes, diskette boxes, computer covers, power block switches, paper and ribbons will be needed eventually.

RECOMMENDATIONS FOR SELECTING AND PURCHASING SOFTWARE

Choosing appropriate software is probably the single most important decision to be made. The optimum method of selecting software is to preview the program before purchase. Some software publishers and retail computer stores have an educational preview policy. Project IMPAC has a comprehensive educational software library and a preview lab that is open to all teachers in Arkansas.[59]

In previewing the software, the following questions need to be addressed:

Does the educational content of the software fit the grade level intended?

- Is the content accurate and free of errors?
- Is the documentation clear and detailed?
- Are instructional guidelines included in the documentation?
- Does the program serve the purpose for which it was intended?
- Are the program instructions clear?
- If the software has management, does it diagnose student's abilities, prescribe an appropriate level of instruction and monitor student performance?
- Does the program provide motivation by good use of graphics?
- Is there sufficient interactivity by providing immediate feedback?
- Does the program randomize problems and examples?
- Is adequate practice given to the student?
- Do educational games stress instructional values rather than game format?

When preview is not possible, it is recommended that software evaluation sources be consulted before purchase. Following is a listing of these sources and three software evaluation forms that may be duplicated and used by software evaluators. Project IMPAC also publishes a Recommended Courseware list which is available to all schools.

Software Evaluation Sources

1. The Digest of Software Reviews: Education
2. The Educational Software Selector (TESS)
3. Educational Products Information Exchange (EPIE)
4. MicroSIFT
5. Minnesota Department of Education (High Quality Courseware List)
6. Minnesota Educational Computer Consortium

The Educational Software Selector - (TESS)

*Review sources utilized by TESS:

1. Booklist
2. Classroom Computer Learning
3. Curriculum Review
4. Courseware Report Card
5. Educational Computer
6. Electronic Learning
7. EPIE Micro-Courseware PRO/FILES
8. Educational Technology
9. Foreign Language Teaching Programs: A Volume of Reviews
10. InfoWorld
11. MicroSIFT
12. Users, MECC Publications
13. SECTOR Project
14. School MicroWare Reviews
15. The Computer Teacher

Addresses of Evaluation Sources and Estimated Cost:

1. The Digest of Software Reviews: Education
   1341 Bulldog Lane
   Suite C
   Fresno, CA 93710

   Estimated cost: $89.00/year

2. The Educational Software Selector (TESS)
   Teachers College Press & EPIE Institute
   1234 Amsterdam Avenue
   New York, NY 10027

   Estimated cost: $59.95/year

3. Educational Products Information Exchange (EPIE)
   P.O. Box 839
   Water Mill, NY 11976

   Estimated cost: $365.00/year

4. MicroSIFT
   Northwest Regional Education Laboratory
   300 S.W. Sixth Avenue
   Portland, OR 97204

   Estimated cost: $138.00/year

5. Minnesota High Quality Courseware List
   Minnesota Curriculum Services Center
   3554 White Bear Avenue
   White Bear Lake, MN 55110

   Estimated cost: 56.90/year

6. Minnesota Educational Computer Exchange
   2520 Broadway Drive
   St. Paul, MN 55113

   Estimated cost: Varies, but is reasonably priced

SOFTWARE EVALUATION FORM

Part I Program Descriptors

1. Title: ______________________________

____

2. Brief Description: ______________________________

____

3. Length (in minutes): ______________________________
4. Computer: ______________________________

____

5. Memory/O-S: ______________________________

____

6. Format (tape or disk): ______________________________
7. Support Material: ______________________________

____

____

8. Subject: ______________________________

____

9. Topic: ______________________________
10. Grade Level: ______________________________
11. Level of Difficulty (high, medium or low): ______________________________

____

12. Objectives: ______________________________

____

____

13. Prerequisites: ______________________________

____

____

COMMENTS:

Part I - Program Descriptors - provides an example of the type of information required for cataloging courseware. --Copy as needed--

--Copy as needed--

Part II - Instructional Applications

(5 = always appropriate, 1 = never appropriate)

1. Drill and practice	1 2 3 4 5	NA	Comments:
2. Skill maintenance	1 2 3 4 5	NA	
3. Review of facts	1 2 3 4 5	NA	
4. Tutorial	1 2 3 4 5	NA	
5. Concept introduction	1 2 3 4 5	NA	
6. Concept reinforcement	1 2 3 4 5	NA	
7. Small - group activity	1 2 3 4 5	NA	
8. Large - group/class activity	1 2 3 4 5	NA	
9. Simulation	1 2 3 4 5	NA	
10. Experimentation/demonstration	1 2 3 4 5	NA	
11. Data manager	1 2 3 4 5	NA	

Part III - Presentation Quality

(5 = outstanding, 1 = poor)

1. Screen layout	1 2 3 4 5	NA	Comments:
2. Consistency of format	1 2 3 4 5	NA	
3. Content accuracy	1 2 3 4 5	NA	
4. Directions	1 2 3 4 5	NA	
5. Clarity of format/question	1 2 3 4 5	NA	
6. Length	1 2 3 4 5	NA	
7. Use of graphics	1 2 3 4 5	NA	
8. Use of sound	1 2 3 4 5	NA	
9. Error trapping	1 2 3 4 5	NA	

Part IV - Instructional Quality

(5 = outstanding, 1 = poor, 0 = does not exist)

1. Appropriateness of content	1 2 3 4 5	Comments:
2. Appropriateness of examples	1 2 3 4 5	
3. Appropriate level of difficulty	1 2 3 4 5	
4. Sequencing of examples/questions	1 2 3 4 5	
5. Help functions	0 1 2 3 4 5	
6. Use of formative evaluation	0 1 2 3 4 5	
7. Branching	0 1 2 3 4 5	
8. Quality of test items	0 1 2 3 4 5	
9. Number of items/questions	0 1 2 3 4 5	
10. Use of review	0 1 2 3 4 5	
11. Introduction	0 1 2 3 4 5	

SOFTWARE EVALUATION FORM

Reviewer's Name: ____________________ Date of Review: ____________________

Address/Phone: ____

Program Title ____________________ Medium: ___ 5" disk, ___ 8" disk

___ cartridge, ___ tape

Package Title ____________________ Copyright Date (if any) ____________

Microcomputer (brand, model, memory) ________________________________

Necessary Hardware ____________________ Necessary Software ____________________

Producer ____________________ Author(s) ____________________

Back-up Copy Policy ____________________ Cost ____________________

PART 1 - PROGRAM OVERVIEW AND DESCRIPTION

1. Subject area and specific topic
2. Prerequisite skills necessary
3. Appropriate grade level (circle) 1 2 3 4 5 6 7 8 9 10 11 12 college
4. Type of program (check one or more)
    - ___Simulation
    - ___Educational Game
    - ___Drill and Practice
    - ___Tutorial
    - ___Problem Solving
    - ___Testing
    - ___Classroom Management
    - ___Other (specify) ____________________
    - ___Remediation
    - ___Enrichment
5. Appropriate group instructional size: ___individual ___small group ___class
6. Is this program an appropriate instructional use of the computer? ____________
7. Briefly list the program's objectives. Are they clearly stated in the program or in the documentation? Are they educationally valuable? Are they achieved?
8. Briefly describe the program. Mention any special strengths or weaknesses.

PART 2 - EVALUATION CHECKLIST

Please check Yes, No or Not applicable for each question below. To add information, or to clarify an answer, use "Comments" at the end of each section.

YES	NO	N/A	EDUCATIONAL CONTENT
______	______	______	1. Is the program content accurate?
______	______	______	2. Is the program content appropriate for intended users?
______	______	______	3. Is the difficulty level consistent for material, interest and vocabulary?
______	______	______	4. Is the program content free of racial, sexual or political bias?

Comments: ____

YES	NO	N/A	PRESENTATION
			1. Is the program free of technical problems?
			2. Are the instructions clear?
			3. Is the curriculum material logically presented and well organized?
			4. Do graphics, sound and color, if used, enhance the instructional presentation?
			5. Is the frame display clear and easy to read?

Comments: ____________________

YES	NO	N/A	INTERACTION
			1. Is the feedback effective and appropriate?
			2. Do cues and prompts help students to answer questions correctly?
			3. Can students access the program "menu" for help or to change activities?
			4. Can students control the pace and sequence of the program?
			5. Are there safeguards against students "bombing" the program by erroneous inputs.

Comments: ____________________

YES	NO	N/A	TEACHER USE
			1. Is record-keeping possible (within the program or through documentation worksheets)?
			2. Does teacher have to monitor student use?
			3. Can teacher modify the program?
			4. Is the documentation clear and comprehensive?

Comments: ____________________

PART 3 - OVERALL EVALUATION

Check One.

________ Excellent program. Recommend without hesitation.

________ Good program. Consider purchase.

________ Fair. May want to wait for something better.

________ Not useful. Do not recommend purchase.

**Evaluation form developed for general use by Granite School District, Salt Lake City, Utah
--Copy as needed--

RECOMMENDATIONS FOR IN-SERVICE TRAINING

The training of teachers and administrators in the effective use of microcomputers in instruction is an essential part of any well-developed computer instruction program. Any in-service session should include:

- Information on computers and their uses.
- Preview and evaluation of courseware.
- Instructional uses of computers.

Further in-service for high school educators will naturally depend on the method and curriculum area in which the computers will be used.

IMPAC, with the help of some leaders in computer instruction, has developed a plan for a statewide in-service program which includes three levels of training. While these in-service guidelines have been primarily aimed at educators on the elementary level, these training programs could equally provide the basic computer skills needed for the high school educator or administrator. These courses are currently being offered at most colleges and universities in Arkansas. Level I will provide training required for teachers who use microcomputers for computer-managed, and/or computer-assisted instruction. Level II includes the training needed by instructional leaders to assist in a variety of computer based education programs. Level III in-service offers the training required to serve as a consultant in educational systems and software development and to serve as an in-service training instructor for Level I and II sessions.

Level I in-service is recommended for all teachers using computers in the classroom. Vendors are a source for this training. Historically, educators have had to look to the college of math or computer science for the above courses. However, these courses are now being offered in several institutions in Arkansas in the colleges of education, technical education division.

In-Service Programs

Most colleges and Universities in Arkansas are offering courses that meet Level I guidelines. Additional training on the Level II or III can be obtained at those institutions listed below. This list is not intended to be all inclusive and any college or university that offers Level II or III training can be added to this list by notifying the Project IMPAC staff at (501) 371-1401.

Level II:

Arkansas State University

Arkansas Tech

Harding University

Henderson State University

Ouachita Baptist University

University of Arkansas at Fayetteville

University of Arkansas at Little Rock

University of Arkansas at Monticello

University of Arkansas at Pine Bluff

University of Central Arkansas

Westark Community College

Level III:

Arkansas State University

Arkansas Tech

University of Arkansas at Fayetteville

University of Arkansas at Little Rock

Introduction to Microcomputers and Their Instructional Applications In-service Training Level I

Any teacher involved in instructional applications of microcomputers needs a minimum of 24 clock hours of pre-service or in-service instruction. The training should involve one of the actual computers and other associated hardware to be used by the teacher. Software comparable to the software to be used in classroom instruction should also be available. Teachers should develop the ability to understand the capabilities of microcomputer technology as it relates to computer-managed and computer-assisted instruction in a self-contained, departmental or laboratory setting.

The following is an outline of a recommended 24 clock hour course that should meet the objectives stated above:

1. Keyboarding Skills - 2 hours

   a. Identification of the keys, the role of each and especially those that perform special functions when the student interacts with software
   b. Break and reset
   c. Clear screen procedure
   d. Special and multiple function keys

2. Interacting with Software - 4 hours
   a. Loading and saving a program
   b. Auto and soft disk boots
   c. Running and controlling a program
   d. Interacting with courseware
   e. Break and reset technique
   f. Obtaining and working from a menu
   g. Keying in short programs and executing

3. Terminology - 3 hours
   a. CPU/ROM/RAM
   b. Input/output
   c. Cassette/floppy disk/hard disk
   d. Monitor: Display characteristics and capabilities
   e. Load, Save, Run, List
   f. Motherboard/bus
   g. Catalog/directory

4. Microcomputer Instructional System - 4 hours
   a. Microcomputer with ROM and RAM
   b. Monitor and keyboard
   c. External storage - floppy disk and hard disk
   d. Printer
   e. Floppy disk characteristics and usage
   f. Utility programs
   g. Clock/counter/random number generators

5. Instructional Uses - 4 hours
    a. Networks
    b. Categories of computers used in education
    c. Specific CAI strategies
    d. Definitions of cost effectiveness
    e. Strategies for maintaining technology awareness
    f. Selecting software keyed to objectives
    g. Classroom instructional management and organization

6. Courseware Evaluation - 4 hours
    a. Evaluation criteria/evaluation forms
    b. Sources of courseware evaluations
    c. Matching courseware and instructional objectives
    d. Pricing techniques
    e. User groups
    f. Public Domain
    g. Vertical files of courseware
    h. Backups

7. Issues Related to Computer Based Instruction - 2 hours
    a. Cost justification
    b. Literacy
    c. High tech jobs in perspective
    d. Copyright laws
    e. Courseware/hardware compatibility
    f. Equity in access to computers
    g. Budget priorities
    h. Privacy

8. A View to the Future - 1 hour
    a. Evolution of computers and their impact on society
    b. Authoring languages
    c. LOGO/PILOT
    d. Word processing
    e. Interactive video
    f. Minicomputer systems
    g. Textbook/courseware supplements
    h. Handheld computers/cartridges of courseware

The Computer As An Instructional Tool
Microcomputer In-service Training Guides, Level I[47]

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College of Education, University of Arkansas
1985

Core Modules

Meeting the Computer
- Lesson 1: Putting Educational Computers in Perspective
- Lesson 2: Getting Started and Having Fun Doing it
- Lesson 3: Basic Computer Components, Terms and Operations
- Lesson 4: What to do when it doesn't work

Instructional Uses of Computers in Education
- Lesson 5: Instructional Applications of Computer Software
- Lesson 6: Instructional Uses of Word Processing
- Lesson 7: What Benefits to the Learner Can we Expect From Using Computers
- Lesson 8: Integrating the Computer into Teaching and Instruction

Classroom and School Management Applications
- Lesson 9: Overview of Management Applications
- Lesson 10: One Management Application In-depth

Care of Computers and Computer Programs
- Lesson 11: Care of Hardware
- Lesson 12: Care of Software and Copyright Considerations

Specialty Modules

Management
- Lesson 13: Word Processing
- Lesson 14: Grade Books
- Lesson 15: Skeleton Programs
- Lesson 16: Test Generation Programs
- Lesson 17: Computer Managed Instruction
- Lesson 18: Teacher Utilities

Hardware
Lesson 19: Buying your own Computer
Lesson 20: Peripherals and Their Applications

Software
Lesson 21: New Trends in Software
Lesson 22: Sources

Issues and the Future
Lesson 23: Issues and the Future

A copy of *The Computer as an Instructional Tool: Microcomputer In-service Training Guides, Level 1* or *The School Computer Coordinator: Microcomputer In-service Training Guides, Level 2* may be secured by teachers of Level 1 or Level 2 in-service classes by writing:

Project IMPAC
Arkansas Department of Education
State Education Building
Little Rock, AR 72201

Planning and Coordinating Instruction
Applications of Microcomputers Level II Training

Instructional coordinators should be prepared to help teachers with Level I training to use computers as instructional and management tools. The coordinator should be able to help teachers incorporate the use of computers into their instructional program. This involves the designing of unit or single lesson plans, evaluation of courseware, instructional strategies and the selection of the components of microcomputer systems. The training of the instructional coordinator should place emphasis on instructional strategies, introductory programming skills and microcomputer systems appropriate to meet specific educational objectives over a five (5) year period. A recommended course outline is given below and assumes an equivalence of prior Level I training.

1. Scope of Computer-Assisted Instruction Activities - 6 hours
    a. Drill and Practice
    b. Tutorial
    c. Simulation
    d. Gaming
    e. Problem solving
    f. Word processing
    g. Criteria for selection of appropriate instructional activity

2. Software Evaluation and Selection - 9 hours
    a. Software review guidelines
    b. Sources of reviews
    c. Selection of software relative to instructional objective
    d. Technical requirements - RAM/hardware/language
    e. Pricing
    f. Vertical files of software
    g. Organizing and maintaining a software library
    h. Maintenance of software and hardware

3. Integrating Computers into Instructional Units - 6 hours
    a. Research on CAI
    b. Laboratory/stand alone
    c. Scheduling and supervising CAI/time on task
    d. Modes of instruction - drill and practice/tutorial/games
    e. Formative and summative evaluation

4. Instructional Support Software - 9 hours
    a. Computer-managed instruction/tracking student progress
    b. Data base systems
    c. Word Processing
    d. Spreadsheets
    e. Teacher Utilities
    f. Testing and evaluation programs

5. Programming Skills - 9 hours
    a. Flow charts
    b. Introduction to Basic
    c. Other instructional languages
    d. Introduction to graphics, sound and color

6. Developments in Computer Technology - 3 hours
    a. Brief history of computers
    b. Applications of computers in business, government, medicine and science and industry
    c. Limitation of computers
    d. Privacy issues
    e. Information processing and distribution
    f. Modems/Compuserve/The Source

7. Microcomputer Instructional Systems - 6 hours
    a. Types of microcomputers and standard features/hardware evaluation
    b. Peripheral devices
    c. Future trends

* Participants attending the Arkansas Leadership Conference on Microcomputer Instruction In-service Training generally agreed that three levels of training may not meet the needs of Arkansas educators. It was recommended that Level IIB training be developed to focus on the needs of the curriculum leaders in schools i.e. principals, curriculum specialists, library media specialists and superintendents. These individuals would probably have little use for programming skills now outlined in Level II, but would need the knowledge and skill to effectively integrate computer technology into the school curriculum. A format for regional conference based on Level IIB training has been developed by the IMPAC staff. Level IIB training is essentially defined by the outline in this resource document.

The School Computer Coordinator
Microcomputer In-service Training Guides, Level 2[48]

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Core Modules

Philosophy of the Computer in Education
- Lesson 1: Computers as in Instructional Technology
- Lesson 2: District Computing Plans and Planning Documents
- Lesson 3: Computers in the Individual School

Applications of Computing in Local Settings
- Lesson 4: Instructional Applications
- Lesson 5: Integration of the Computer into Curriculum
- Lesson 6: Management Applications

Administration of Computer Software and Hardware in Schools
- Lesson 7: Software Acquisition and Management
- Lesson 8: Management and Purchase of Hardware

Specialty Modules

Software
- Lesson 9: In-depth study of software packages for a specific subject area

Other Curricular Components
- Lesson 10: Computers and Communications Technology Curriculums
- Lesson 11: Computer Science Curriculums

Programming and Languages
- Lesson 12: BASIC Programming
- Lesson 13: LOGO

Management Software
- Lesson 14: Word Processing Applications
- Lesson 15: Data Base Applications
- Lesson 16: Spreadsheet Applications
- Lesson 17: Integrated Program Applications

Issues and Trends
- Lesson 18: Self-Selected Issues

Planning and Coordinating Instruction
Applications of Microcomuter Level III Training

Computer Based Instructional Consultants should be prepared to help teachers and coordinators with Level I and Level II training to use computers as management and instructional tools. Consultants should be experienced educators that can assist in the selection of appropriate computer systems for specific educational programs. Technical knowledge of software adaptation, the development of utility programs, and efficient uses of such peripherals as disks and printers represent the breadth of the consultant's knowledge. One role of the consultant is that of instructor in Level I and Level II courses. A recommended course outline is given below and assumes skills equivalent to those outlined in Level I and Level II training. Level III training, regardless of the course outline, should provide sufficient training in order for the consultant to help educators acquire knowledge of how to:

1. Integrate computers into specific content areas

2. Supervise and coordinate software collections

3. Develop software programs

4. Organize Level I and Level II courses

5. Coordinate hardware and peripheral application

6. Supervise the selection and maintenance of hardware

7. Direct or coordinate evaluations of microcomputer related instructional programs

8. Stimulate and maintain computer interests with students, teachers, administrators, parents, school board officials and the public

    a. Identify, evaluate and recommend instructional software - 12 hours
        (1) Coordination of resources and curricular objectives
        (2) Identification of review sources
        (3) Evaluation of software
        (4) Trends in voice recognition and speech synthesis equipment

    b. Design and develop instructional courseware - 27 hours
        (1) Identification of instructional objectives
        (2) Design of courseware
        (3) Develop courseware with programming language or authoring system
        (4) Develop accompanying support material
        (5) Adaptation or modification of previously prepared courseware

c. Utility Programs - 9 hours
    (1) Identification of available utility programs
    (2) Diagnostic software
    (3) Test generators
    (4) Graphics utilities
    (5) Data base systems
    (6) Remote data base systems - the sources and cost

d. Securing and Managing software packages - 9 hours
    (1) Acquisition policies
    (2) Licensing and back-up
    (3) Cataloging
    (4) Storage
    (5) Distribution

e. Hardware Selection - 15 hours
    (1) Hardware characteristics
    (2) Computer Systems related to CAI and CMI
    (3) Networking
    (4) Interfacing peripherals such as floppy and hard disk, printer and modem
    (5) Hardware maintenance through diagnostic programs

f. Societal Issues - 6 hours
    (1) Legal and ethical
    (2) Social and psychological
    (3) Economic
    (4) Privacy of information
    (5) Equality of access

g. Computer Integration - 9 hours
    (1) Appropriate content for grade level activities
    (2) Instructional design - supplementary/unit/course
    (3) Selection of instructional materials and software
    (4) Evaluation of student achievement

h. Instructional Leadership Training - 48 hours
    (1) Procedures for conducting Level I and Level II courses
    (2) Elementary knowledge of Basic, LOGO, PILOT and PASCAL
    (3) Knowledge of current sources of information and research related to instructional application of microcomputers
    (4) Procedures and techniques for dissemination of information
    (5) Principles of instructional design and curricular integration
    (6) Organizing Instructional Programs - laboratory versus classroom usage
    (7) Evaluation of the major microcomputers used in education
    (8) Mixed modes of media and computers

ELECTRICAL AND SPACE REQUIREMENTS FOR MICROCOMPUTERS

Electrical Requirements for Microcomputers in the Regular Classroom (Stand Alones)

Electrical power to stand alone microcomputer systems should be stable and noise free. A good electrical system includes a permanently installed metal conduit, three #12 copper 19 strand THHN wires for hot, neutral and ground, and the proper number of receptacles for each computer work station. For example, Apple IIe systems have two plugs -- one for the microcomputer and one for the monitor. Commodore 64s have three plugs -- one for the microcomputer power pack, one for the monitor and one for the disk drive. One plug must be allotted for each printer. A good earth ground should be established at the closest circuit breaker. These are the minimum specifications recommended for a school classroom. On occasion, additional equipment must be added to ensure a good usable microcomputer system.

Surge arrestors (G.E. part no. TLP175V) installed in the closest circuit breaker panel will protect all circuits on that panel against surges above 175 volts. Metal Oxide Varistors (MOVs) (G.E. L Series MOV part no. V150LA20B) stacked (H to N, N to G, H to G) in the first receptacle box will protect that computer circuit from externally and internally generated positive spikes above 150 volts. Isolation transformers and line conditioners can be installed to protect against the damaging positive spikes and high line voltages and the frustrating negative spikes and sagging voltages. Switch(es), double pull or single throw for both the hot and neutral, can be installed to turn off and on groups of microcomputers at the same time. The service of a certified/licensed electrician or an educational technologist knowledgeable of microcomputer electrical specifications for specific systems should be utilized.

Electrical Requirements for Microcomputers in a Laboratory (Network)

Electrical power to a networked microcomputer system should be stable and noise free. A network exists when several microcomputers are linked together using a small wire or cable trunk line that carries information or data between computers, printers and storage devices. The networked computers can be located in one room, which is called a "networked lab", or in many classrooms, which is called a "networked classroom system". A good electrical system includes a permanently installed, dedicated metal conduit, three #12 copper 19 strand THHN wires for hot, neutral and ground and the proper number of receptacles for each computer work station and printer or other auxiliary equipment as needed. A good earth ground should be established at the closest circuit breaker panel. The computers must be on dedicated electrical circuit(s). If more than one circuit is used, ensure that all circuits are on the same electrical phase. Allow 1.5 amps for each computer work station. An additional 1.5 amps should be allowed for each printer and hard drive. Some network systems require ground isolated receptacles and an isolated ground system. In this case, such as the Corvus Omninet, bond all the gound wires in the dedicated computer circuits to a #6 THHN copper wire which connects to a dedicated 8 feet minimum grounding rod. This is the minimum configuration recommended for a school classroom. If needed, additional equipment can be added to ensure a good usable microcomputer system.

The specifications on surge arrestors, Metal Oxide Varistors, transformers, line conditioners and switches are the same as those previously described.

Electrical Requirements for Micorcomputers in Regular Classrooms (Networked)

The recommendations given in the preceding section apply. In this case, the data trunk line runs to all classrooms encompassed by the network. The requirement for dedicated electrical circuits in the same place and from the same distribution panel should be followed. The hard disk drive for the network is usually located in the classroom of the teacher that serves as the key operator.

Lighting, Floor Covering, Space, Furniture and Dust Control

The lighting in a computer room should meet the standards for a regular classroom. Microcomputer systems should not be placed near heating or cooling units, or located so that students face windows without shades. Try to avoid configurations that would result in glare off the monitor screens.

No special floor coverings are required. However, concrete floors are not recommended due to excessive dust. Vinyl tile covered floors are good. If carpet is installed, it must be static fee and cleaned properly to remove dust and dust particles. Furniture specifications should always meet any state guideline established by School Plant Services. In general, tables with non-folding adjustable legs and wood table tops should be at least 30 inches deep and have appropriate height to meet the working heights of students and be at least six feet in length. Each student computer work station should be 36 inches wide. The station using the printer will require 24 inches. This means in a typical elementary classroom with four computers and one printer, one six foot table, one eight foot table or equivalent built-in space, four chairs and appropriate electrical receptacles will be needed. Space needs for this configuration and other configurations are given below:

Work #Stations	# 6 Foot Tables	# 8 Foot Tables	Chairs	Minimum Room Space Needed
2	0	1	2	48 sq. ft.
4	1	1	4	84 sq. ft.
6	2	1	6	120 sq. ft.

In a laboratory configuration follow the recommendations given for tables used in a regular classroom program for work space allotment. An entire classroom will be needed for any given laboratory configuration. An extra eight foot table is needed as a teacher control-monitor station. Built in student work stations are considered a good alternative to tables and can usually be designed to provide a better learning environment. Suitable isles and a small study area for, at most, four students should be provided.

Work # Stations	# 6 Foot Tables	# 8 Foot Tables	Chairs	Minimum Room Space Needed	Typical Room Space

16	6	2	16	336 sq. ft.	480
24	10	2	24	504 sq. ft.	720
30	14	2	30	630 sq. ft.	900

Covers for the computer monitor, computer, disk drive and printer are recommended. Large plastic leaf bags will suffice if funds are limited. Liquid chalkboards are recommended in new classrooms or laboratories or when old chalkboards are replaced.

Summary of Research Related to Electrical Requirements for Microcomputer Use

The electrical outlets for your computers should provide steady reliable power. This is most important when computers are tied together via a high speed communications "local area network" (LAN). Electrical power utilities are often blamed for "dirty power" but most induced current affecting microcomputers and computer networks is generated after it leaves the main source and before it arrives at the classroom outlet. Most of these electrical power problems are of the following types:

1. Low voltage on an electrical distribution system, referred to as a brown-out, may be caused by localized overloads between the main commerical power system and local distribution, uncontrolled area wide reduction of voltage caused by extremely heavy demand over a large area, and controlled deliberate area wide reduction of voltage by the power company to prevent a blackout.

2. Black-outs or power outages in which no electrical power is available in a given locale or large area may be caused by an overload condition within a school building that causes the circuit breaker to trips, a local distribution failure in which a pole mounted transformer or circuit breaker is damaged or a power failure caused by large area wide problems such as severe weather.

3. Alternating current (AC) line irregularities may exist due to at least six causes: lightning discharges from a flash occurring up to several miles away; switching of nearby inductive loads from motors, air conditioners, fans or large relays; electrostatic discharges or static electricity; nearby radio and television stations and loose electrical connections and fluorescent lights.

Causes of "dirty power" or... "noise" may be miles away from the school, in another building on campus or in the room down the hall. Almost never attributed to a single source, they are usually the sum of numerous disruptive influences. There is little the electric power company can do. It is the user's responsibility to protect his or her equipment against these problems.

Normally, educational microcomputer systems are not protected from brown outs and black outs. If the power goes off, fluctuates or electrical thunderstorms are in the area, the teachers should turn off the computers or shut down the computer network. After it has been verified that the power is good, the teacher may turn on the computer systems again.

If the electrical power to the computers is on a dedicated circuit with little inductive noise and well-grounded, surge protectors will generally be adequate. Line irregularities can be reduced by having a licensed electrician ensure that the electrical outlets to be used by the computer systems are noise free and well-grounded. If they are not, the electrician could take the following steps.

Install a dedicated circuit from each room back to a common circuit breaker panel. This circuit should consist of a hot wire, a neutral wire and a ground wire and be carried in a conduit, dedicated especially for the computer systems. Connect these three wires to receptacles with ground in the room and to the circuit breaker, a neutral bar and ground bar in the circuit breaker panel. A good earth ground should be established at that common circuit breaker panel. A grounding rod should be installed below that panel. All conduits should be secured tightly. The circuit breaker panel box should be bonded to the earth ground and to the ground wire from the conduit. It is important that all computer systems that are tied together through networks have the same ground reference, that is, no electrical potential should exist between the ground in one outlet or plug versus another.

Specific plans and specifications for your particular network needs can be developed by a network specialist. A qualified licensed electrician should complete the installation and monitor the quality of electrical power with a BMI Line Monitor and determine if other line filtering or voltage regulation is necessary. Good clean electrical power is a must for a network.

APPENDIX A

Teachers of Experimental Classes in IMPAC Project Schools 1984-85

CMI-CAI

Fayetteville

Cordinator: Burt Stark
Jefferson Elementary School

Teachers:	Grade
Nancy Gordon	4
Judy Stirewalt	5
Ann Wilson	6

Fort Smith

Coordinator: Wallace Floyd
Ft. Smith School District

Teachers:	Grade
Susan Pillar	4
Paul Williams	5
James Hail	6

Monticello

Coordinator: Sue Hickam
City Park School

Teachers:	Grade
Betty Busby	4
Marie Carroll	5
Shirley Carpenter	6

Pine Bluff

Coordinator: Paula Waymack
Indiana Street School

Teachers:	Grade
Bobbie Atkinson	4
Ardeen Bryant	5
Elaine Osburn	5
Evelyn Halbrook	6
Tommie Hunthrop	6
Gertrude Schimmel	6

Pulaski County

Coordinator: Janie Naylor
Pine Forest School

Teachers:	Grade
Delores McNeil	4
Eddyce Lofton	5
Nancy Sherman	6

Vilonia

Coordinator: Mary Wells
Vilonia Elementary School

Teachers:	Grade
Helen Vowan	4
Sunnie Ruple	5
Denisce Pierce	6

C-AIM

Jonesboro

Coordinator: Wilbur Green
South School

Teachers:	Grade
Cheryl Carty	3
Sue Davis	3
Jane Foster	4
Mary Ellen Qualls	4
Rosenell Hester	5
Carol Bishop	5

West Memphis

Coordinator: Gerald Park
Richland Elementary School

Teachers:	Grade
Nell Gibson	3
Jessie Smith	4
Joyce Rudd	5
Pam Meggers	6

C-CAI

Conway

Coordinator: Jim Stone
Conway Middle School

Teachers:	Grade
Geneva Bowlin	6

Hot Springs

Coordinator: George Robinson
Oaklawn Elementary School

Teachers:	Grade
Dorothy Lee	4
Sheila Burroughs	4
Alice Lloyd	5
Phylis Coffmann	5
Betty Brown	6
Katie Weaver	6

Marshall

Coordinator: Franklin Lewis
Marshall Elementary School

Teachers:	Grade
Sue Geoghagan	4
Jo Anne Fountain	4
Larry Clingings	5
Pat Neel	5
Alice Daniel	6
Bernelle Mathis	6

Waldron

Coordinator: J. D. McGee
Waldron School District

Teachers:	Grade
Carol Youngblood	4
Tama Martin	4
Charlotte Segman	5

Gould

Coordinator: James Raby
Gould Elementary School

Teachers	Grade
Ernestine Lang	4-6
Deborah Harrison	4-6

Little Rock

Coordinator: Jim Hardwick
Mitchell School

Teachers:	Grade
Debbie Finkbinder	4
Nora Robinson	4
Nell Page	5
Edith Powell	5
Sharon Harris	6
Dazzle Matttison	6

Stuttgart

Coordinator: David Wood
Stuttgart Middle School

Teachers:	Grade
Patricia Howey	4
Janie Hickman	4
Annie Bradford	5
Clarence Hatch	5
Pat Davis	6
Regina Earlywine	6

A-CAI

Benton

Coordinator: Frank Chenault
Caldwell Elementary School

Teachers:	Grade
Mary Ward	5
Polly Caldwell	6

El Dorado

Coordinator: Lynn Snell
Southside School

Teachers:	Grade
Eloise Nelson	4
Mary Sue Porchia	4
Gina Baker	5
Donna Harrison	5
Charney Dodson	6
Barbara Honeycutt	6

Mammoth Spring

Coordinator: Ruth Shaw
Mammoth Spring Elementary

Teachers:	Grade
Peggy Roger	3
Peral Martin	4
Janet King	4
Rick Billingsley	5
LaJune Bateman	5
Jan Pike	6

Texarkana

Coordinator: Betty Norton
Washington Intermediate School

Teachers:	Grade
Kathleen Heflin	4
Kenneth Anthony	4
Chayta Mills	5
Betty Norton	5
Kathy McKenzie	6
Margarite Hillier	6

Corning

Coordinator: Niles Cherry
Central Elementary School

Teachers:	Grade
Sue Taylor	4
Janet Harmon	4
Robert Pritchett	5
Judy Smith	5
June Bland	6
Terry Rapert	6

Gurdon

Coordinator: Bill Moorman
Gurdon Middle School

Teachers:	Grade
Julia Smithson	4
Rita Strickland	4
Peggy Hargrave	5
Nedra Williams	5
Belinda Whitlock	6
Wilma House	6

So. Miss. Co.

Coordinator: Jimmy Allen
Wilson Elementary

Teachers:	Grade
Doris McDaniel	4
Verlene Logan	4
Martha Thomas	5
Lois Watson	5
Stella Seals	6
J. C. Nanney	6

APPENDIX B

Sample Correlations Between IMPAC Courseware and Arkansas Basic Skills

Basic Skills - Grade Four

Whole Number Numeration	Fundamentals of Math	The Pet Professor	Mathware	Classroom Learning Systems	Mathematics San Diego	Science Research Associates Level B
1.1	yes	no	yes	no	yes	yes
1.2	no	no	yes	no	yes	yes
1.3	yes	no	no	no	yes	yes
1.4	no	no	yes	no	yes	yes
Whole Numbers						
2.1	yes	yes	yes	yes	yes	yes
2.2	yes	yes	no	yes	yes	yes
2.3	yes	yes	no	yes	yes	yes
2.4	yes	no	yes	no	yes	yes
2.5	yes	no	yes	yes	yes	yes
2.6	yes	yes	no	yes	yes	yes
2.7	yes	no	yes	yes	no	yes
2.8	yes	no	yes	yes	yes	yes
2.9	yes	yes	yes	yes	yes	yes
Rational Numbers						
3.1	no	no	yes	no	yes	yes
3.2	yes	no	no	no	yes	yes
Measurement						
4.1	yes	no	yes	no	no	no
4.2	yes	no	yes	no	no	no
4.3	yes	no	yes	no	no	no
4.4	no	no	no	no	yes	no
Geometry						
5.1	yes	no	no	no	yes	no
Probability and Statistics						
6.1	yes	no	no	no	no	no

Basic Skills - Grade Five

Whole Number Numeration	Fundamentals of Math	The Pet Professor	Mathware	Classroom Learning Systems	Mathematics San Diego	Science Research Associates Level C
1.1	yes	no	yes	no	yes	yes
1.2	no	no	yes	no	yes	yes
1.2	yes	no	no	no	yes	yes
Whole Numbers						
2.1	yes	yes	yes	yes	yes	yes
2.2	yes	yes	yes	yes	yes	yes
2.3	yes	no	yes	no	yes	yes
2.4	no	yes	yes	yes	yes	yes
2.5	yes	yes	yes	yes	yes	yes
2.6	yes	yes	yes	yes	yes	yes
2.7	no	no	yes	no	yes	yes
Rational Numbers						
3.1	yes	yes	yes	no	yes	yes
3.2	yes	no	yes	no	yes	yes
3.3	yes	yes	no	no	yes	yes
3.4	yes	no	no	no	yes	yes
3.5	yes	no	yes	no	yes	yes
3.6	yes	yes	yes	no	yes	yes
3.7	yes	yes	yes	no	yes	yes
Measurement						
4.1	yes	no	yes	no	no	no
4.2	yes	no	yes	no	yes	no
4.3	no	no	no	no	no	no
4.4	no	no	no	no	yes	no
Geometry						
5.1	yes	no	no	no	no	no
5.2	yes	no	yes	no	yes	no
Probability and Statistics						
6.1	yes	no	yes	no	yes	no

Basic Skills - Grade Six

Whole Number Numeration	Fundamentals of Math	The Pet Professor	Mathware	Classroom Learning Systems	Mathematics San Diego	Science Research Associates Level D
1.1	yes	no	no	no	yes	yes
1.2	no	no	no	no	yes	yes
1.3	yes	no	no	no	yes	yes
1.4	yes	no	no	no	no	yes
1.5	yes	no	no	no	no	yes
Whole Numbers						
2.1	yes	yes	no	yes	yes	yes
2.2	yes	yes	no	yes	yes	yes
2.3	no	yes	yes	yes	yes	yes
2.4	yes	yes	yes	yes	yes	yes
Rational Numbers						
3.1	yes	no	yes	no	yes	yes
3.2	yes	no	yes	no	yes	yes
3.3	yes	yes	yes	no	yes	yes
3.4	yes	yes	yes	no	yes	yes
3.5	yes	no	yes	no	yes	yes
3.6	yes	no	yes	no	yes	yes
3.7	yes	no	yes	no	yes	yes
3.8	yes	no	no	no	yes	yes
3.9	yes	no	no	no	yes	yes
3.10	yes	yes	yes	no	yes	yes
Measurement						
4.1	yes	no	no	no	yes	yes
4.2	yes	no	yes	no	no	yes
4.3	yes	no	yes	no	no	yes
4.4	yes	no	yes	no	no	no
4.5	no	no	no	no	yes	no
Geometry						
5.1	yes	no	no	no	no	no
5.2	yes	no	no	no	no	no
5.3	yes	no	yes	no	no	no
5.4	yes	no	yes	no	yes	yes
5.5	yes	no	yes	no	yes	yes
5.6	yes	no	yes	no	yes	yes
Probability and Statistics						

Basic Skills - Reading	Skillcorp Software Reading	Diascriptive Reading I and II	ICT
Word Recognition			
1.1	yes	yes	yes
1.2	yes	yes	yes
1.3	yes	yes	yes
1.4	yes	yes	yes
1.5	yes	yes	yes
1.6	no	yes	yes
1.7	yes	no	yes
1.8	no	no	yes
1.9	no	no	yes
1.10	no	yes	yes
1.11	no	yes	yes
Comprehension			
2.1	yes	yes	yes
2.2	yes	yes	yes
2.3	yes	yes	yes
2.4	yes	yes	yes
2.5	no	no	yes
2.6	yes	no	yes
2.7	yes	no	yes
2.8	yes	no	yes
2.9	yes	yes	yes
2.10	yes	no	yes
2.11	no	no	yes
Study Skills			
3.1	yes	no	no
3.2	yes	no	no
3.3	yes	no	no
3.4	yes	no	no
3.5	yes	yes	no
3.6	yes	yes	no
3.7	yes	yes	yes
Listening			
4.1	no	no	no
4.2	no	no	no
4.3	no	no	no
4.4	no	no	no
Oral Communication			
5.1	no	no	no
5.2	no	no	no

APPENDIX C

Criteria for Selection of IMPAC Experimental Schools

The following list outlines the criteria that has been identified by the Arkansas Commission on Microcomputer Instruction to be used in the process of selecting the schools for the first phase of IMPAC. Project schools will be selected from those districts that return the completed application on or before August 1, 1983.

1. District records indicating the status of students' basic skills achievement in grades 3-8 and also indicating a need and plan for improving basic skills instruction in mathematics, reading and language arts.

2. Local school board and administrative commitment to participate in all phases of the IMPAC program: release time for staff training; providing necessary security, housing, tables, chairs, electrical wiring and test data for evaluation purposes.

3. Building level principal's commitment to become trained in the IMPAC microcomputer program to be used by the project school, to serve as project coordinator and maintain the coordinator's diary on significant activities related to the IMPAC program.

4. Evidence of the interest and willingness of teachers in the project school to be participants in the project.

5. Evidence that the instuctional staff has been actively involved in one or more major curriculum or staff improvement programs over the past two years.

6. Evidence that there is a well-planned sequentially developed program, grades 1-6, in mathematics, reading and language arts in which computer assisted and computer managed instruction can be provided on a supplementary basis through an IMPAC program.

7. Evidence of local business, industry or other community computer related resources that may or may not be available to the project school.

8. Demographic characteristics of the school will also be used to assure representative sampling throughout the state with regard to school size and geographic area.

IMPAC
Instructional Microcomputer Project for Arkansas Classrooms

Procedures for Selecting School Districts

1. Approximately 22 school districts will be selected to participate in IMPAC during 1983-85.

2. In most cases, the principal of the project school will serve as program coordinator for the IMPAC program. The responsibilities of the coordinator include leadership in program implementation, monitoring of the effectiveness of the program and serving as a liaison person to the IMPAC office.

3. The district must have credible evaluation data, including standardized student test scores, which show improvement gains or losses over the two years immediately preceding the implementation of the IMPAC program. For evaluation purposes, standardized test scores over the four year period 1981-85 will also be required on all students participating in the IMPAC program. SRA scores obtained annually in grades 3, 4, 5 and 6 are acceptable. Any test is acceptable if it is a nationally standardized test that measures achievement in mathematics, reading, language arts and provides a grade level equivalent score.

4. In implementing an IMPAC program, teachers will be expected to participate in 4-6 days of in-service training over a two year period. The first two days will be scheduled when the hardware and software are first installed. Additional one-day workshops will be scheduled as needed. The dates will be selected as conveniently as possible. Districts selected to participate are expected to provide release time for participating teachers. The coordinator, the principal of the project school, will be expected to attend all workshops. The superintendent is expected to participate in the first two-day workshop.

5. The IMPAC programs are designed to relate to one elementary school in a school district that includes grades 3-6. The principal and several teachers will be involved. A district should identify the school that is most likely to be the project school. If the school organization is such that grades 3-6 are not located at the same school site, then more than one school will need to be identified.

6. The organizational patterns being used in a district's elementary schools affects the selection and implementation of specific IMPAC programs. For example, a teacher working in an elementary school that is departmentalized in mathematics and reading may teach several classes in the same subject. Therefore, 6-8 microcomputers may be needed in the classroom or 16-24 in a lab for students to do CAI. Teachers in self-contained classrooms may need only 4 microcomputers for CAI in mathematics, reading and language arts.

7. The school district is expected to provide chairs, tables and electrical wiring related to the IMPAC program. If the district is provided the opportunity to install a lab, a room of adequate size must be provided by the district. Specifications for all electrical wiring will be provided by the IMPAC Education Technologist. Electrical wiring related to networked microcomputers must be supervised by the IMPAC Educational Technologist.

8. IMPAC will provide the cost of insurance for the hardware and maintenance for the hardware and software for two years. The district will not have ownership of the hardware and software until the research phase is complete. The district and IMPAC will maintain inventory records on the hardware and software for the purpose of audit and in-service.

9. The project school's principal will maintain a diary of the relevant facts related to the project, including a record of software and hardware maintenance problems. The principal will be provided with a diary and specific instructions on how to maintain the diary. A copy of the diary will be requested at the end of each semester during the two year program.

10. Once a school district is notified of its selection to participate in IMPAC, the superintendent must provide a letter to the IMPAC Project Director certifying that the School Board has agreed to have the school participate in IMPAC and accepts the various responsibilities established in this document.

11. Meetings will be held with representatives of the selected schools to provide technical assistance in planning.

12. Once the program selected has been approved in writing by the IMPAC Project Director, the hardware and software needed will be secured. It is likely that a cooperative implementation plan will be developed among school districts implementing the same IMPAC programs.

All inquiries should be made to:

Dr. Cecil McDermott, IMPAC Project Director, or
Mr. John Fortenberry, IMPAC Project Administrator
State Department of Education
State Education Buildings
Little Rock, AR 72201
(501) 371-1401

TERMINOLOGY

1. Backup copy - A duplicate copy

2. Byte - Represents one character such as a letter and is usually 8 bits in length

3. CAI - Computer-Assisted Instruction

4. C-AIM - A basic skills testing program with management features, Computer-Assisted Instruction Management

5. CMI - Computer-Managed Instruction

6. CMI-CAI - Computer-Managed Instruction with Computer-Assisted Instruction

7. Computer - Any device with a self-contained memory which can receive information, process it, store it and follow instructions to manipulate that information

8. Courseware - The computer programs together with the teacher materials, workbooks and guides

9. CPU - Central Processing Unit--The part of a computer which controls the operation of other parts of the computer

10. CRT - Cathode Ray Tube--The display part of a television, monitor or video terminal

11. Cursor - A movable spot on the CRT screen. Shows the programmer or operator where the pointer is located

12. Debug - Locating and eliminating errors

13. Disk - A device that looks like a phonograph record on which large amounts of data may be stored

14. Documentation - A written description of a computer program. It allows one to understand the purpose and logic of a program.

15. Drill and Practice - A type of computer program which acts as a drillmaster by providing repetitive practice on some basic skill or set of facts

16. Execute - To run a computer program

17. Hardware - Any physical part of a computer or computer related equipment

19. Hard disk - A disk that usually holds the equivalent of numerous floppy disks of information

20. K - A unit of measurement for memory size in computers (one K is 1024 bytes).

21. Memory - The portion of a computer in which data is stored

22. Network - Two or more microcomputers connected together by a trunk line to a disk drive and printer

23. Noise - Induced voltage that is irregular and distorts the electrical current. This causes problems with the proper operation of microcomputers and networks

24. Objectives - The results to be achieved by using the program and materials as outlined

25. Printer - A device that makes hard copies of computer output

26. Program - A list of instructions given to the computer in a language it can understand, telling it to perform a specific task

27. Programmer - A person who translates problem solutions steps into computer programs

28. RAM - Random Access Memory--memory available to user

29. ROM - Read Only Memory--memory built into the computer by the manufacturer. This memory cannot be changed.

30. RUN - A command telling the computer to execute the program in memory

31. Simulation - A type of computer program which recreates a real-world situation for examination

32. Software - Refers to computer programs which instruct the computer how to operate

33. Syntax error - A computer response to a mistake in the way a command is given or spelled

34. Trunk line - The line in a network that connects the computers together with a hard disk drive and printer

35. Tutorial - A type of computer program which provides new information as well as repetitive drill and practice in the teaching of a basic skill or set of facts

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